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CONTENTS

PRODUCTION-CONSUMPTION RELATIONSHIPS OF EDIBLE FATS AND PROTEINS FROM ANIMALS AND OILSEEDS

By K. M. Decossas[1] and R. M. Persell[2]

INTRODUCTION

During the past 50 years, the world oilseed, meat, and dairy industries have made a major contribution in providing more edible protein in foods and feeds. Cereals alone, which supply almost half of the world's protein, cannot provide adequate nutrition unless they are improved genetically, fortified with missing amino acids, or supplemented by higher protein plants such as pulses and oilseeds. Today scientists throughout the world are working to develop varieties of cereal grains with higher quality protein in greater quantities. In addition, the production of dietary protein from conventional and unconventional sources is expanding.

The information in this paper was developed as a part of a study to determine the influence of world fat and oil consumption on protein supply. The paper concerns past, present, and future world and U.S. production of edible fats and oils as they influence edible protein supplies from commodities that yield both types of products. The production and values of fat and oil and protein from various oilseeds, red-meat animals, and milk are compared. Per capita consumption of fats and oils and the relationship of oil value and meal value are also discussed. U.S. data are referred to extensively because of this country's important role in world food supply.

The study is confined to edible fats, oils, and proteins except for the categories of "world edible and inedible tallow and grease," for which an edible category is not available separately, and "U.S. exports of fats and oils," which includes inedible tallow and grease and oils used in inedible products, namely linseed, coconut, fish, tung, and castor oils. Because of the influence that exports of these inedible fats and oils might have on the exports of edible products, they were included with exports.

Unless otherwise stated, "animal fat" means edible fat from red-meat animals (beef, veal, pork, lamb, and mutton) and milk fat. "Oil" refers to edible oil from oilseeds. The proteins considered are from the same sources plus fish, since fish protein is competitive with and shares common markets with some of the other proteins, especially the oilseed proteins. Edible proteins are those used in foods and feeds.

Each of the 109 figures, which are classified in the categories indicated in the "Guide to Figures" at the beginning of the appendix, contains both long- and short-term trends with projections to 1985, marked "L" and "S," respectively. The long-term trend with projection is based on data from 1946 to 1970, and the short-term trend with projection is based on data from 1961 to 1970. Annual rates of increase and decrease were determined from the slopes of the trend lines. Projections to 1985 of dollar values are valid only insofar as inflation, or dollar depreciation, continues at the rate of the past 25 years.

U.S. PRODUCTION OF EDIBLE VEGETABLE OIL AND OILSEED AND FISHMEAL PROTEINS

Between 1920 and 1970 U.S. production of vegetable oils (including oil equivalent of oilseed exports) increased 8-fold, from 1.8 billion pounds in the 1920's to 15.2 billion pounds in 1970 (fig. 1). The United States was the only nation to emerge from World War II strong enough to meet world needs for fats and oils. Ninety percent of the increase occurred after World War II, an average annual increase of 5.9 percent having been sustained during the 1946-70 period. U.S. vegetable oil production almost doubled during the 1950's and again during the 1960's.

The uses and annual increases in production since World War II of the principal edible vegetable oils are as follows:

Corn oil.—Used chiefly for domestic polyunsaturated fats such as margarine and cooking oil; 3.7 percent.

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Safflower oil.—Production began in 1946; used like corn oil; 23.5 percent.

Soybean oil.—Large variety of food and industrial uses; 9.5 percent, from 1.5 billion pounds in 1946 to 7.9 billion in 1970.

Peanut oil.—0.64 percent.

Edible oil equivalent of oilseed exports.—Consisted almost entirely of soybeans; 39.6 percent, from 35 million pounds in 1946 to 5 billion in 1970 (figs. 12-15, 17).

In addition, 40 million pounds of sunflowerseed oil was produced in 1967 and 2 million pounds in 1961 (fig. 16).

U.S. coconut oil production declined at an annual rate of 1.9 percent from 1946 to 1970; from 1961 to 1970 the annual decline was 3.0 percent (fig. 12). This decline reflects greater imports of coconut oil, which have, to an extent, replaced domestic production of the oil from imported copra.

U.S. cottonseed oil production also declined during these periods: 0.10 percent annually from 1946 to 1970 and 4.8 percent from 1961 to 1970 (fig. 12). In the late 1960's soybean oil replaced cottonseed oil in many food uses because of lower cotton production. Improved oil extraction and processing have upgraded the quality of vegetable oils and thereby have advanced their interchangeability and lessened supply problems.

The dramatic increase in U.S. production of fats and oils (fig. 8) averted famine and serious malnutrition in the war-ravaged countries of Europe and Asia. At about the same time, rapidly expanding poultry and red-meat industries have created large-volume markets for high-protein feeds, particularly from soybean, cottonseed, peanut, and fishmeals. This coincided with world awareness of protein deficiencies in human nutrition (*4*).[3]

The 11-fold increase in production of oilseed protein (including protein equivalent of oilseed exports) was similar to but greater than the development in vegetable oil production and ranged from an average 2.5 billion pounds annually during the 1920's to 28.4 billion pounds in 1970 (figs. 1, 19). The average annual rate of increase for oilseed protein production during the 1946-70 period was 6.2 percent; for the corresponding vegetable oils it was 5.8 percent. Protein production increases and decreases for individual oilseeds followed the pattern of their corresponding oils (figs. 20-24). The production of linseed protein, whose corresponding oil is inedible, decreased an average of 2.4 percent annually (fig. 23). Production of fishmeal protein, which shares the market with oilseed protein in animal feeds increased an average of 0.8 percent annually during the same period (fig. 21).

Great advances in the science of animal nutrition were made during the 1930's, 1940's and 1950's, and it was during this period that the protein fraction of oilseeds became the product instead of the byproduct (*9*). The oilseed and fish proteins produced in the United States (including protein equivalent of soybean exports) have found ready markets at home and abroad in animal feeds, while soybean protein has been processed into flour, concentrates, and isolates for human consumption. Soy protein food products now range from the whole bean and full-fat flour containing about 40 percent protein to isolated soy protein containing nearly 100 percent protein on a moisture-free basis. During the past decade, a variety of textured soy protein food products has appeared in supermarkets and restaurants. An estimated 192 million pounds of soy protein flours, concentrates, and isolates was used in foods in the United States in 1969 (*10*).

Projections of two trends, one beginning with the end of World War II and the other during the 1960's, indicate that by 1985 U.S. production of vegetable oils could reach 18 to 23 billion pounds, and U.S. production of oilseed and fish proteins could reach 34 to 45 billion pounds (figs. 1, 11, 19). Although U.S. soybean use may have reached a plateau, worldwide protein needs indicate that there will be increased demand. Soybeans are in a dominant position because they are a primary product and have a relatively high ratio of protein to oil. Soybeans yield approximately 2 pounds of protein for every 1 pound of oil (fig. 28). No other major oilseed produces more protein than oil except cottonseed.

VALUE OF U.S. EDIBLE VEGETABLE OILS AND OILSEED AND FISHMEAL PROTEINS

Between the decade of the 1920's and 1970 the value of vegetable oils produced in the United States increased more than 12-fold, from $151 million to $1.9 billion annually (fig. 2). In contrast, the value of their protein counterparts increased almost 20-fold, from $132 million to $2.6 billion annually. The value of fishmeal protein increased more than 8-fold from $6.9 million to $58.7 million (fig. 40). The average annual rates of value increase for the postwar period were 4.4 percent for vegetable oils and 8.3 percent for oilseed meal proteins. Most vegetable oils and oilseed proteins increased in

[3] Italicized numbers in parentheses refer to items in "Literature Cited" preceding the appendix.

total value (figs. 30-35, 40-44). The exceptions were babassu, coconut, cottonseed, and peanut oils and coconut and linseed proteins, all of which decreased slightly (figs. 31-33, 42).

The higher rate of increase in the value of oilseed meal protein is largely attributable to the fact that U.S. and world demands for protein have been growing steadily, causing increases in domestic meal prices over the past two decades, while surpluses of domestic vegetable oils have depressed oil prices.

Projections indicate that by 1985 the value of U.S. production of vegetable oils could reach $2 to $2.5 billion annually, and the value of the protein counterpart, including fish and linseed meals, $3 to $4 billion annually (fig. 2).

WORLD PRODUCTION OF EDIBLE VEGETABLE AND PALM OILS AND OILSEED AND FISHMEAL PROTEINS

An optimistic picture is presented by the increases in world production of vegetable oils and palm oils combined and their proteins. These increases substantially exceed the annual rate of world population growth of 2.1 percent (fig. 3). For example, the production of vegetable oils and palm oils more than doubled between 1947 and 1970, while production of oilseed and fishmeal proteins almost tripled. In this period the combined production of these oils increased from 10.4 million metric tons to 23.9 million metric tons, and the production of protein increased from 8.2 million metric tons to 24 million metric tons. These increases represent an average annual increase in production of vegetable oil of 4.7 percent; of palm oils of 2 percent; and of oilseed and fishmeal proteins of 5.9 percent.

In 1970 world production of oilseed and fishmeal proteins surpassed production of vegetable oils and palm oils for the first time. This is attributable to increased production of U.S. soybeans, which have a high ratio of protein to oil.

Increased production of soybeans, cottonseed, sunflowerseed, peanuts, and rapeseed has chiefly accounted for increased world production of vegetable oils and oilseed proteins since 1947 (figs. 49-52, 56-60). Improved technology and a growing oilseed extraction industry in developing countries have contributed to these higher productions. For example, India's cottonseed industry doubled its capacity in the 1960's and was estimated to have expanded its crushings from 18 percent of production in 1961-62 to 36 percent of production in 1970-71 (*8*).

Regrettably, the increase in world production of vegetable oils and oilseed proteins at a rate greater than world population growth does not always benefit human nutrition. Sizable quantities of the protein content of oilseeds are exported from areas of production where nutritional needs are greatest, principally to developed countries for use as animal feed and fertilizers. For example, India, a nation with great nutritional needs, exports part of the protein content of its oilseed output (*6*).

By 1985 world production of vegetable and palm oils could reach 31.6 to 36.3 million metric tons annually, and production of oilseed proteins could be 33.6 to 38.9 million metric tons (fig. 3).

U.S. PRODUCTION OF EDIBLE ANIMAL FATS AND PROTEINS

During the past five decades, U.S. production of milk fat and red-meat animal fats increased at a rate lower than population growth (figs. 4, 63). The production of animal fats increased from 6.2 billion pounds in the 1920's to 6.8 billion pounds in 1970. During the 1946-70 period, milk fat, butter, and lard production decreased slightly, while oleo oil and stearine production decreased 7.8 percent annually and edible tallow production increased at an average annual rate of 11.2 percent (figs. 11, 18, 63, 64). The decline in the production of animal fats during the 1946-70 period is evidence of the shift to polyunsaturates in the diet and of the production of leaner animals to meet the needs of modern consumers. For example, more selective breeding of hogs has meant larger, leaner loins and hams (*2*). Vegetable oils displaced animal fats in the U.S. food-fat economy mainly because of (1) the sharp growth in output of soybean oil at competitive price levels; (2) increased hydrogenation processing, which made possible the manufacture of shortening entirely from vegetable oils; (3) consumer shift from butter to lower priced vegetable oil margarine; and (4) trend of diet- and cholesterol-conscious consumers toward using more unsaturated oils and less solid saturated fats (*11*).

U.S. production of animal proteins almost doubled between the decade of the 1920's and 1970, surpassing the production of animal fats and sustaining an average annual increase of 1.8 percent (figs. 4, 63). Production increased from 6 billion pounds in the 1920's to 11 billion pounds in 1970. The principal gainers were beef, pork, meat meal, and tankage (figs. 25-27). Milk protein production increased at a rate of 0.07 percent annually,

veal declined 2.5 percent annually, and mutton declined 1.9 percent annually.

Meat protein has the most desirable quality, and U.S. production has increased to supply the growing demand created by the rising incomes in the United States. Since World War II meat meal and tankage use in the U.S. feed industry has increased at a sustained rate of 5.4 percent annually, and it has emerged as an important competitor in feed markets.

U.S. PRODUCTION OF MILK-FAT AND MILK-PROTEIN PRODUCTS

In this study the figures for the production of milk-fat products are the sum of the weights of consumer milk products containing more fat than protein plus one-half of the weight of whole-milk products, since whole-milk products contain approximately equal amounts of fat and protein. Likewise, the figures for the production of milk-protein products are the sum of the weights of milk products containing more protein than fat plus the other half of the weight of whole-milk products. The weight of liquid milk consumed is included in both the production of milk-fat products and milk-protein products as follows: Production of low-fat and liquid skim milk is included in the production of milk-protein products, and liquid whole-milk production is divided equally between the production of milk-fat products and milk-protein products.

Production of milk-protein products increased 75 percent more than production of milk-fat products during the 1920-70 period (fig. 62). The production of milk-fat products increased from 35.8 billion pounds in 1946 to 38.4 billion pounds in 1965; it declined to 36.2 billion pounds in 1970. The output of milk-protein products increased more than 20 percent, from 38 billion pounds in 1946 to 47 billion pounds in 1970.

Of the milk-fat products, the production of ice cream and sherbet increased between 1946 and 1970, while production of cream and butter decreased (figs. 63, 64). Whole-milk products registering production increases were liquid whole milk, condensed whole milk, American cheese, and ice milk, and those with production decreases were evaporated whole milk, dry whole milk, and dry malted milk (figs. 65, 66, 69, 71).

Almost all milk-protein products have grown substantially in volume since World War II. Big gainers include low-fat liquid milk, cheeses, cottage cheese, nonfat dry milk, dry whey, mellorine, and evaporated and condensed skim milk (figs. 67-70, 72, 73). A lesser gain was realized for dry buttermilk, and decreases occurred for concentrated skim milk for animal feed and condensed or evaporated buttermilk (fig. 72). Clearly, American tastes have shifted toward low-fat and frozen milk products.

Projections indicate that by 1985 U.S. production of milk-fat products could total 33.6 to 39.4 billion pounds and production of milk-protein products could amount to 50.1 to 51.6 billion pounds (fig. 62).

U.S. PRODUCTION OF EDIBLE RED-MEAT ANIMAL FAT AND PROTEIN

U.S. production of edible red-meat animal fat, the byproduct of red-meat production, decreased from 2.6 billion pounds in the 1920's to 2.4 billion pounds in 1970 (fig. 4). At the same time, production of red-meat protein increased 2.5-fold, from 2.8 billion pounds in the 1920's to 6.9 billion pounds in 1970. This study indicates that the increase in the production of protein has been accompanied by an increase in the production of inedible tallow and grease, rather than by an increase in the production of edible red-meat fat. The decrease in production of edible fat is due to the decline in the production of lard (fig. 18). The increase in the production of edible tallow has not offset the decrease in lard production.

Red-meat protein production is the total of protein in edible red meat for human consumption and of protein in meat meal and tankage for feed. The humanly edible protein was calculated on the basis of the dressed carcass weight of the animals: 14.9 percent in beef, 18.8 percent in veal, 10.2 percent in pork, and 16.5 percent in lamb and mutton. Feed protein was calculated on the basis of 52 percent in meat meal and tankage. Projections indicate that by 1985 the production of animal fat will amount to 1.8 to 2.9 billion pounds and its protein counterpart will total 9.4 billion pounds.

VALUE OF U.S. EDIBLE ANIMAL FAT AND PROTEIN

Between the decade of the 1920's and 1970 the value of animal protein increased at a rate almost 3 times the rate of increase in value of its fat counterpart (figs. 5, 74). The value of milk-fat products more than tripled,

while the value of red-meat fat declined slightly. Milk-fat products and red-meat fats together increased more than 2.5-fold, from $1.8 billion in the 1920's to $5.0 billion in 1970. In contrast, the value of their protein counterparts increased almost 7-fold. Since World War II the average annual rates of increase have been 0.37 percent for edible animal fat and 2.9 percent for edible animal protein.

VALUE OF U.S. MILK-FAT AND MILK-PROTEIN PRODUCTS

The value of milk-protein products increased at a rate 2.3 times greater than the rate of increase in value of milk-fat products during the 1921-70 period (fig. 74). The value of milk-fat products increased at an average annual rate of 0.61 percent, from $3.8 billion in 1946 to $4.7 billion in 1970. The value of milk-protein products increased at an average annual rate of 3.3 percent, from $2.0 billion in 1946 to $4.4 billion in 1970. Of the milk-fat products, the value of ice cream and sherbet increased between 1946 and 1970, while the value of cream and butter decreased (fig. 75). Whole-milk products having value increases were liquid whole milk, condensed whole milk, American cheese, and ice milk (figs. 76-78). Those having value decreases were evaporated whole milk, dry whole milk, and dry malted milk (figs. 77, 78).

The value of all milk-protein products grew substantially after World War II, except for decreases in the value of concentrated skim milk for animal feed and condensed or evaporated buttermilk (figs. 79-84). Short-term projections indicate that the value of milk-protein products could exceed that of milk-fat products before 1975; and by 1985 the value of milk-fat products could be worth $4.9 to $5.7 billion; compared to $5.1 to $6.8 billion annually for milk-protein products.

VALUE OF U.S. EDIBLE RED-MEAT ANIMAL FAT AND PROTEIN

The value of red-meat animal protein increased 6.7-fold during the 1921-70 period, in contrast to a slight decline in value of its fat counterpart (fig. 5). In 1970 the protein was worth 67 times as much as the fat. Since 1946, the value of U.S. red meat has increased annually: beef, 5.1 percent; pork, 1.3 percent; and meat meal and tankage, 5.4 percent (figs. 45-47). The value of veal declined 2.1 percent annually and mutton, 1.8 percent (fig. 46). During the same period lard value declined 3.7 percent annually, oleo oil value declined 19.4 percent annually, and stearine value declined 6.2 percent annually, but the value of edible tallow increased 9.3 percent annually (figs. 36, 37). By 1985 U.S. animal fats could be worth $96.4 to $198.5 million annually and the protein, $21.7 to $29.1 billion (fig. 5).

WORLD PRODUCTION OF ANIMAL FATS AND EDIBLE ANIMAL PROTEINS

World production of animal fats (including milk-fat, lard, and edible and inedible tallow and grease) and of edible animal proteins (including proteins from milk, beef, veal, pork, and mutton) more than doubled between 1947 and 1970 (figs. 6, 7). The production of fats increased from 10.4 million metric tons in 1947 to 23.3 million metric tons in 1970, and protein production increased from 9.5 million metric tons in 1947 to 22.7 million metric tons in 1970.

WORLD PRODUCTION OF MILK FAT AND MILK PROTEIN

Production of milk fat and milk protein increased at an annual rate of more than 4 percent between 1947 and 1970, substantially above the annual rate of world population growth of 2.1 percent (fig. 6). Milk-fat production increased from 6.3 million metric tons in 1947 to 15.2 million metric tons in 1970, while milk-protein production increased from 6.0 million metric tons to 14.3 million metric tons.

In contrast to the decline in U.S. butter production of 1.2 percent annually during the period, world butter production increased an average of 2.6 percent annually because of increased consumption in developed countries excluding the United States (fig. 49). In developing countries butter production has remained relatively steady. In India and east Africa, ghee, the best known stable butterfat product, is produced on a large scale (*1*). In India it comprises about 20 percent of the total annual consumption of fats and oils, and it is the chief butter produced in Pakistan.

By 1985 world production of milk fat has been projected at 20.3 to 22.9 million metric tons, and of milk protein, 19.2 to 21.6 million metric tons (fig. 6).

WORLD PRODUCTION OF RED-MEAT ANIMAL FAT AND EDIBLE RED-MEAT PROTEIN

During the 1947-70 period production of lard increased at an annual rate of 0.83 percent, and edible and inedible tallow and grease increased 4.0 percent (figs. 7, 53, 54). Protein from beef and veal increased 4.3 percent; from pork, 3.2 percent; and from mutton, 2.4 percent (fig. 61).

Although these increases substantially exceed the annual 2.1-percent world population growth, the supply benefits are confined to the 40 countries where the most production and consumption occur. Consumption of meat protein is nearly five times as great in the developed countries as in the developing countries (*3*). The United States, Brazil, and Argentina predominate in beef production and Australia and New Zealand lead in mutton and lamb, while pork is prevalent in Europe. Increases in animal-protein production have taken place where there has been an excess of grain over and above the needs of human food or when conditions have been favorable for grazing of cattle.

Projections indicate that in 1985 world production of animal fat could amount to 10.5 million to 11.0 million metric tons, and production of edible red-meat animal protein could be 11.4 million to 11.7 million metric tons (fig. 7).

TOTAL U.S. PRODUCTION AND VALUE OF EDIBLE FATS, OILS, AND PROTEINS

The foregoing data for U.S. vegetable and animal fats and proteins have been combined to provide the following production and value data for total edible U.S. fats, oils, and proteins (figs. 8, 9). Total U.S. production of fats and oils increased at an average annual rate of 2.7 percent during the post-World War II period, from 10.1 billion pounds in 1946 to 21.9 billion pounds in 1970 (fig. 8). During that time U.S. production of proteins from oilseed, fish, milk, and red-meat animals increased 4.1 percent annually, from 14.0 billion pounds in 1946 to 39.7 billion pounds in 1970. Projections indicate that production of fats and oils could reach 25.6 to 28.7 billion pounds annually by 1985, and production of proteins could be 48.0 to 57.8 billion pounds annually.

Since World War II virtually all growth in U.S. production of fats and oils has been provided by vegetable oils, which constituted 69 percent of U.S. production of fats and oils in 1970, but only 31 percent in 1946 (fig. 11). If these trends continue, by 1985 vegetable oils will comprise 70 to 80 percent of U.S. production of fats and oils.

Virtually all growth in U.S. production of protein since World War II has been provided by oilseeds, fishmeal, beef, pork, and meat meal and tankage (figs. 19, 25, 27). Oilseed and fishmeal proteins increased from 45 percent of U.S. protein in 1946 to 73 percent in 1970 (fig. 19). Red-meat protein decreased from 26 to 17 percent, and milk protein from 29 to 10 percent. It has been projected that oilseed and fishmeal proteins could comprise 71 to 78 percent of U.S. production of proteins by 1985.

The value of total U.S. edible fats and oils increased at an average annual rate of 1.0 percent during the post-World War II period, from $4.7 billion in 1946 to $6.9 billion in 1970 (fig. 9). During that time, the value of protein increased 3.3 percent annually, from $9.0 billion in 1946 to $25.7 billion in 1970. Projections indicate that the annual value of fats and oils could reach $6.9 billion to $8.3 billion by 1985, and the value of proteins could be $29.8 billion to $40.0 billion.

Since World War II, two-thirds of the increase in the value of U.S. fats and oils has been provided by vegetable oils, the value of which increased from 10 percent of U.S. fats and oils in 1946 to 28 percent in 1970 (fig. 29). The increase in value of animal-fat products during the period accounted for the remaining one-third of value increase. Although milk fat accounted for virtually all of the value increase of animal-fat products, it comprised only 68 percent of U.S. fats and oils value in 1970, compared to 81 percent in 1946.

Although vegetable oils accounted for two-thirds of the increase in value of all fats and oils since World War II, the proteins derived from them did not increase in value as much as the proteins from milk and animal fat (fig. 38). Although edible oilseed protein increased in total dollar value less than did milk or animal proteins, yet it increased in value at an annual rate 2 to 3 times faster than these other proteins. Figure 39 illustrates the faster rate of increase of oilseed and fish protein. The relatively low increase in total dollar value of oilseed protein coupled with its high production increase reflects the low price of the fastest growing segment of U.S. production of protein (fig. 19). In 1970 oilseed and fish proteins comprised 10 percent of the value of U.S.

edible proteins; milk protein products, 17 percent; and red-meat proteins, 73 percent (fig. 38). It has been projected that these percentages will not change significantly to 1985.

TOTAL WORLD PRODUCTION OF EDIBLE FATS, OILS, AND PROTEINS

World production of proteins has been increasing 30 percent faster than world production of fats and oils (fig. 10). Total world production of fats and oils increased at an average annual rate of 3.7 percent during the post-World War II period, from 20.8 million metric tons in 1947 to 47.3 million metric tons in 1970. During that time, world production of proteins increased 4.8 percent annually, from 17.7 million metric tons in 1947 to 46.7 million metric tons in 1970. Soy protein has achieved the greatest expansion in production of proteins over the past 23 years, the world production having more than quadrupled (fig. 56). With a volume of only one-fourth that of soybeans, fishmeal protein production increased 12-fold during the same period. Sunflower protein increased 5-fold (figs. 57, 59), rapeseed protein supply increased only 6.2 percent, and peanut protein increased two-thirds, while palm and cottonseed proteins more than doubled (figs. 57, 60). The cottonseed and cottonseed oil supply is dependent on the demand for cotton fiber. Projections indicate that production of fats and oils could reach 64.9 million to 67.6 million metric tons annually by 1985, and production of proteins could be 66.6 million to 69.8 million metric tons annually (fig. 10).

In 1947 world production of vegetable oil comprised 41 percent of edible fat and oil production, and animal fat production amounted to 50 percent (fig. 48). Between 1947 and 1954, although productions of both vegetable oil and animal fat increased, animal fat increased at a greater rate (the distance between the vegetable oil and animal fat curves in fig. 48 widened), and by 1954 vegetable oil comprised only 30.3 percent of fat and oil production, while animal fat amounted to 56.6 percent. By 1961, however, world production of vegetable oil began increasing at a much greater rate than production of animal fat, until by 1970 vegetable oil accounted for 42 percent of fat and oil production, and animal fat, 49 percent. Palm oils increased from 9 percent of fat and oil production in 1947 to 14.6 percent in 1951, but then steadily declined to 8.4 percent in 1969 and 9.0 percent in 1970. Projections based on the last 10 years indicate that by 1985 world production of vegetable oil could account for 47 percent; animal fat, 46 percent; and palm oils, 6 percent of total edible fat and oil production.

In 1947 world production of oilseed and fishmeal protein comprised 46.5 percent of protein production, while milk protein amounted to 33.7 percent and red-meat protein, 19.8 percent (fig. 55). After a decline to 40.6 percent in 1954, oilseed and fishmeal protein increased steadily to 51.4 percent of world protein production in 1970. The production of milk protein increased from 33.7 percent in 1947 to 39.7 percent in 1954, but since then it has diminished to 30.7 percent. Red-meat protein decreased from 21.1 percent in 1956 to 17.9 percent in 1970. By 1985 edible oilseed and fishmeal proteins have been projected to account for 55.7 percent; milk protein, 27.5 percent; and red-meat protein, 16.8 percent of total edible protein production.

VALUE OF OIL AND PROTEIN PRODUCTS FROM DOMESTICALLY PRODUCED AND IMPORTED OIL-BEARING MATERIALS

Shifts in the relative value of oil and protein have occurred since about 1957. Three-year averages of relative value are plotted in figures 85 through 88. Before 1957 oilseeds were considered primarily as sources of edible or industrial oils, the protein-rich meal having been regarded as a byproduct. However, since 1957 the value of the protein-rich meal has generally increased in relation to oil value, and in the case of soybean, exceeded the value of the oil. (The ratio of oil value to meal value for soybeans has been less than 1 since 1957, as shown in figures 85 and 87.) It has been projected that by 1985 U.S. proteins from oilseeds will be worth 1.6 times the value of the oils, with values of soybean, cottonseed, and flaxseed proteins amounting to 4.3, 1.8, and 1.3 times the values of their oil counterparts, respectively (figs. 85, 86).

During the 1946-70 period, the ratio of oil value to meal value significantly diminished for each major oilseed. For the majority of the major oilseeds, oil value to meal value ratios declined at an annual rate of approximately 2.5 percent over the 24-year period (figs. 87, 88). An exception is the ratio of coconut oil value to meal value, which declined at an annual rate of 1.16 percent (fig. 88). The ratios of oil value to meal value in

1970 were 6.54 for coconut, 1.18 for cottonseed, 1.94 for flaxseed, 2.51 for peanuts, 3.52 for safflower, 0.74 for soybeans, and 3.98 for sunflower.

During the 1960's the ratio of safflower oil value to safflower meal value increased at a rate of 4.7 percent annually (fig. 87). Safflower meal value has been about one-fifth the product value of safflower seed. The meal protein is lower in cost than protein from other available meals in the California-Arizona area; however, "regular" safflower meal has a relatively high crude fiber content and low protein. A new high-protein safflower meal product with reduced fiber content is now commercially available (*7*).

PER CAPITA CONSUMPTION OF FATS AND OILS

U.S. per capita consumption of food fats and oils increased from 42.3 pounds in the 1920's to 52.8 pounds in 1970 (fig. 89). Most of the increase took place after the mid-1960's when per capita consumption was 44 pounds. There has been a distinct trend away from solid fats to liquid oils and from animal fats to vegetable oils. The increased use of fats in foods partly reflects a rising proportion of young people in the population who use convenience and snack foods frequently; growth of "fast food" enterprises; and increased eating out (*11*), all of which denote general national affluence.

U.S. per capita consumption of inedible fats and oils increased from 20 pounds in the 1920's to 29.4 pounds in 1941, after which it declined to 22.4 pounds in 1954, reflecting the loss of markets for agricultural products to synthetics, for example, displacement of soap by synthetic detergents and of linseed oil in protective coatings. It increased steadily to 27.1 pounds in 1969 and 26.1 pounds in 1970.

U.S. per capita consumption of 78.9 pounds of edible and inedible fats and oils in 1970 was more than triple the 23.8 pounds per capita consumption of the world (almost four times the 20.6 pounds per capita consumption of the world excluding the United States). U.S. per capita consumption increased at an average annual rate of 1.3 percent in the 1960's compared to rates of increase for the world of 0.88 percent and for the world exclusive of the United States of 0.85 percent.

World per capita consumption of fats and oils increased from 19.8 pounds in 1950 to 22 pounds in 1960 and 23.8 pounds in 1970. While the world population is growing at an annual rate of 2.1 percent, consumption of fats and oils has been increasing for the past 10 years at an annual rate of 3 percent. This increase has been mainly in edible fats and oils, as fat and oil consumption in industrial uses has been fairly level and, on a per capita basis, has actually been decreasing. The increase in supplies of edible protein corresponding to the fats and oils is at an annual rate of 4.7 percent.

U.S. FAT, OIL, AND PROTEIN EXPORTS

U.S. exports of edible and inedible fats and oils increased from 1.4 billion pounds in 1921 to 10.0 billion pounds in 1970. U.S. exports of fats and oils decreased from 18.8 percent of domestic production in the early 1920's to 2.4 percent of production in the late 1930's (fig. 90). During World War II they increased to 11.1 percent of production, and after World War II they rose steadily from 6.3 percent in 1947 to 35.2 percent in 1963 (3-year averages). After 1963 they declined to between 21.4 to 22.9 percent of production in the late 1960's. In 1970 fats and oils exports increased to 25.8 percent of production.

Except for fish and other marine oils in the pre-World War II period, this general pattern was followed by the major categories of fat and oil exports, namely animal fats, vegetable oils, and fish and other marine oils (figs. 91, 92).

U.S. cottonseed oil exports rose steadily after World War II and reached a plateau during the 1954-56 period, when large quantities of oil were exported from Commodity Credit Corporation holdings and when U.S. cottonseed oil exports accounted for over three-fourths of the total cottonseed and cottonseed oil that entered world trade channels (fig. 93). In subsequent years the movement of cottonseed oil was heavy mainly because of strong demands from the dollar-importing countries of northwestern Europe, exports for local currency, and donations under the U.S. food-for-peace program. In 1966, U.S. cottonseed oil exports began to decline sharply, reflecting the reduction in cottonseed production by one-third in 1966 and the further drop in 1967 to roughly one-half of the output in 1965. Because of this dramatic decline in production, the resulting higher priced U.S. cottonseed oil was not competitive with foreign oils, such as soybean (largely from U.S. beans), sunflower, peanut, and rapeseed. By 1970 U.S. cottonseed oil exports had increased because of lower production in some foreign countries and in response to a strong foreign demand for edible vegetable oils.

In the 1920's exports of U.S. soybean oil were small,

but because soybean oil production was also very small, exports represented a significant percentage of production (fig. 93). As soybean oil production increased during the late 1930's, the percentage exported diminished. Following World War II there was a spectacular rise in exports of soybean oil and soybeans (figs. 93, 101). The expansion of oil and bean exports combined set new records year after year, so that U.S. exports since 1962 have accounted for almost 95 percent of world soybean oil and soybean exports. Strong and growing foreign demand for soybeans and soybean products was occasioned during the past three decades by such factors as short copra supplies; shortages of olive oil in the Mediterranean area; reduced availability of peanuts from West Africa; continued strong demand for soybeans in Western Europe and Japan and for soybean meal in Western Europe; purchases for foreign currencies and donations under various Government programs, including the food-for-peace program; the need for high-protein concentrates to supplement drought-depleted feed supplies; a favorable price relationship of soybean oil to competitive oils; reduced export availabilities of competing oils, particularly sunflower, peanut, and fish oils, and of competing protein meals, particularly fish and peanut meals; the expansion in European and Japanese poultry and livestock production and the consequent demand for soybean meal; and increasing consumption of fats and oils in general resulting from population growth and improving economic conditions in a number of countries. In the middle and late 1960's, U.S. soybean oil exports diminished. There was some recovery in 1967 and 1970. Soybean exports have consistently increased, reflecting a growing demand for soybeans for processing overseas (figs. 93, 101).

Peanut oil exports from the United States were larger during the 1948-51 and 1963-64 periods than at any other time (fig. 94). Exports of peanut oil and peanuts were larger than usual during the 1948-51 period because peanut production remained high after the war, while demand for peanut products as substitutes for scarce foods declined, increasing the availability of peanuts for domestic crushing for oil or for export for crushing abroad (figs. 94, 102). During World War II the peanut program was directed toward increasing production to meet the wartime needs for peanut oil, and the special provisions for encouraging oil production were terminated with the 1951 crop (*12*). Exports of peanut oil and peanuts were larger than usual during 1964-65, reflecting increased production and a record 1965 crop, which provided a substantial exportable supply.

U.S. exports of corn oil have been practically nil except for the World War II period and since 1967. During World War II as much as 15 percent of production was exported, and after 1967 exports gradually increased to 7 percent of production (fig. 95).

U.S. exports of coconut oil have been small, especially recently, reflecting steady domestic demand (fig. 95). Since coconut palms are not grown in the United States, the entire oil supply is imported, either as oil or as copra from which the oil is extracted. Roughly two-fifths of domestic consumption is consumed in food products -- mainly in specialty items such as confectionery and bakery goods, with lesser amounts in shortening and margarine. Nonfood products, such as soap, synthetic detergents, cosmetics, oil additives, fatty acids, and other manufactured goods account for three-fifths of total consumption.

Linseed oil exports from the United States were relatively large during World War II to meet lend-lease needs, during the middle 1950's when the United States disposed of large supplies of linseed oil, and in the late 1960's when domestic consumption continued to decline as a result of displacement of linseed oil in paints and varnishes by nonoil substitutes (fig. 95). Similar fluctuations are evident in flaxseed exports (fig. 101). Linseed oil and flaxseed exports have varied, depending upon U.S. supplies, world availabilities, and price levels.

Exports from the United States of minor inedible vegetable oils, such as tung, castor, babassu, and palm kernel oils, have represented a small percentage of domestic production from domestic and imported materials except during the 1959-61 period when U.S.-held surpluses of tung oil moved into the export market (fig. 96). "Minor vegetable oils" is a combination of corn oil and "minor inedible vegetable oils," both mentioned earlier.

Exports of "all vegetable oils," expressed as a percentage of production, have increased since World War II at an average annual rate of 3.3 percent (fig. 96). Soybean oil exports, the major contributor, grew at a rate of 7.1 percent annually.

U.S. exports of inedible tallow and grease increased dramatically during the past two decades (fig. 97). Domestic markets were unable to absorb inedible tallow and grease production gains caused by growth of U.S. livestock production and slaughter, expansion in the rendering industry, and more efficient recovery of the fats. Consequently, the big expansion was in the export market, which has developed into the largest single outlet. Cattle slaughter and beef output are projected to increase a further one-third by 1980 as a result of a growing demand for beef generated by increasing population and gains in disposable income (*12*). Exports of inedible tallow and grease, as a percentage of

production, have increased an average 3.9 percent annually since World War II.

Although total growth in world exports of vegetable and marine oils and animal fats has been almost constant since 1955, there has been a marked shift in the fraction supplied by the United States. U.S. fat and oil exports during 1960-64 grew 7.3 percent annually over the previous 5-year period. This significant growth rate – more than triple the rate of world population growth – supplemented foreign oil exports during a below-trend period when growth in foreign exports averaged only 2.4 percent annually (*12*). Beginning with 1965, however, there has been a new spurt of growth in foreign oil exports, due largely to increased exports of sunflowerseed and rapeseed. As a result, growth in U.S. oil exports since 1965 has been cut to an average rate of only 2.1 percent annually over the previous 5-year period. Unique factors that influenced growth in foreign oil exports during the 1965-69 period are assumed to have, to some degree, run their course. Nevertheless, instances of dynamic growth, like the increase in sunflowerseed, may occur among other commodities – for example, the sharp increase in world palm oil exports which occurred in 1970. Projections indicate that total U.S. fat and oil exports could amount to 15.8 to 38.2 percent of production in 1985 (fig. 90).

U.S. exports of edible oilseed, fish, and marine meat meals and of animal meal and tankage increased from 508,000 tons in 1921 to 4.3 million tons in 1970. After a steady decline in both tonnage and percentage of U.S. production from the middle 1920's to 1945, U.S. meal exports rose from 180,000 tons in 1946, or 1.24 percent of U.S. meal production, to 4.2 million tons in 1969, or 16.4 percent of U.S. meal production (3-year averages, fig. 98). In 1970 exports increased to 4.3 million tons (17.3 percent of production).

Soybean meal exports comprised virtually all of the increase in U.S. meal exports, having increased from 142,000 tons in 1946 to 4.2 million tons in 1970, or from 3.5 percent of production in 1946 to 23 percent in 1970 (fig. 99). U.S. linseed meal exports have not recovered to their prewar level because of lower production and strong foreign competition (fig. 100).

The world demand for meal, which is used primarily for feed, has been growing much more rapidly than the demand for oil, which is used mainly for food. Since 1955, expansion in U.S. exports of major cakes and meals, including meal equivalent of oilseed exports, has accounted for the major share of the uptrend in world exports of these commodities. U.S. exports expanded 670,000 tons annually, or 13.2 percent – a rate more than double the 5.6 percent annual average growth of foreign exports (*5*).

Exports of soybeans and meal are largely responsible both for the rise in world meal exports since 1955 and for the 1969 record. In 1969 the estimated proportion of soybean meal equivalent to world exports of all meals was 53 percent, as against 49 percent in 1968. It is projected that 18.8 to 41.0 percent of U.S. edible meal production could be exported by 1985 (fig. 98).

The oil equivalent of U.S. oilseed exports has increased from 35 million pounds in 1946 to 5.0 billion pounds in 1970, a 143-fold increase. Soybeans have accounted for virtually all of the increase, with small amounts of flaxseed and peanuts. Soybean exports increased from 1.75 percent of production in 1946 to 31.1 percent of production in 1969 (3-year averages, fig. 101). In 1970 soybean exports reached 4.8 billion pounds, 38.6 percent of production. It is projected that 49.6 to 54.7 percent of soybeans produced in the United States may be exported and that 42.5 to 43.8 percent of major U.S. oilseeds (soybeans, cottonseed, flaxseed, peanuts) may be exported by 1985 (fig. 101). The development of an oilseed extraction industry throughout the free world for the production of oil and meal has stimulated U.S. exports of oilseeds.

U.S. red-meat exports and shipments have been a small percentage of production plus imports except during World War II when exports and shipments reached as much as 7.6 percent (3-year average) of production plus imports (fig. 103). Since 1920 exports of each kind of red meat have varied similarly to exports of all red meat, but in comparison with all red meat a consistently larger percentage of pork production and a consistently smaller percentage of beef and veal production have been exported (fig. 104). With the exception of 1946 and 1947, total exports of pork have exceeded those of beef and veal. Since 1925 the United States has been a net importer of beef, since 1949 a net importer of lamb and mutton, and since 1953 a net importer of pork.

U.S. exports of milk products have historically amounted to only a small part of the domestic production, ordinarily less than 1 percent, on an equivalent basis, of the annual production of milk. Figure 105 shows U.S. exports of selected milk products from 1920 through 1970 with projections to 1985, expressed as a percentage of production of the kinds of milk products exported. Figure 105 is a composite of the exports of individual milk products shown in figures 106 through 109. These figures illustrate that exports of milk products increased sharply during World War II, practically all of the exports having moved under Government programs such as lend-lease. Following World War II, total exports decreased almost without interruption from the wartime peak until about 1952.

Beginning with 1953, owing to the impetus given by Government programs in disposing of surplus milk products, total exports began increasing again, and by 1955 they comprised about 5 percent of domestic output of milk and were equal to 15 percent of total production of the kinds of milk products exported (fig. 105). In 1955 about four-fifths of exported milk products, practically all exports of butter, cheese, and nonfat dry milk, were sponsored under Government programs to feed the needy overseas. Evaporated milk and dry whole milk were able to meet price competition in world markets and comprised a large part of commercial exports of milk products.

Between 1957 and 1961 U.S. exports of milk products decreased mainly because of reduced donation of butter and butter oil, discontinuance of chees shipments, and reduced donations of nonfat dry mill under Section 416 of Title III, Public Law 480. Th 1957-61 trend was reversed during the 1961-64 period a a result of a substantial increase in exports of nonfat dr milk, butter, and cheese under Titles II and III of Publi Law 480 and increased dollar sales of butter to Europe In the late 1960's lower U.S. production, reduce European import requirements, depletion of Commodity Credit Corporation stocks of milk products, and discontinuance of the dairy export program brough about a sharp reduction in overall U.S. exports of butte and nonfat dry milk.

SUMMARY

Edible proteins from oilseeds, red-meat animals, and milk have been increasing in importance in relation to their fat and oil counterparts, and in the United States they are now produced in larger amounts and have a greater value than the fats and oils. Soybeans now hold an advantageous position in the United States and the world because they are a primary product and have a relatively high ratio of protein to oil. Soy protein has achieved the greatest expansion in production of edible protein, the world production having more than quadrupled since 1947. World production of edible fats and oils and proteins are about equal, but trends indicate that protein will shortly forge ahead.

The ratio of oil value to meal value has significantly diminished for each major oilseed in the last 25 years. Projections indicate that proteins from edible oilseeds will be worth 1.6 times the value of the edible oils by 1985.

World consumption of fats and oils has increased at an average annual rate of 3 percent during the past decade and has in turn increased world edible protein supply at an average annual rate of 4.7 percent.

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APPENDIX. – FIGURES

Guide to Figures

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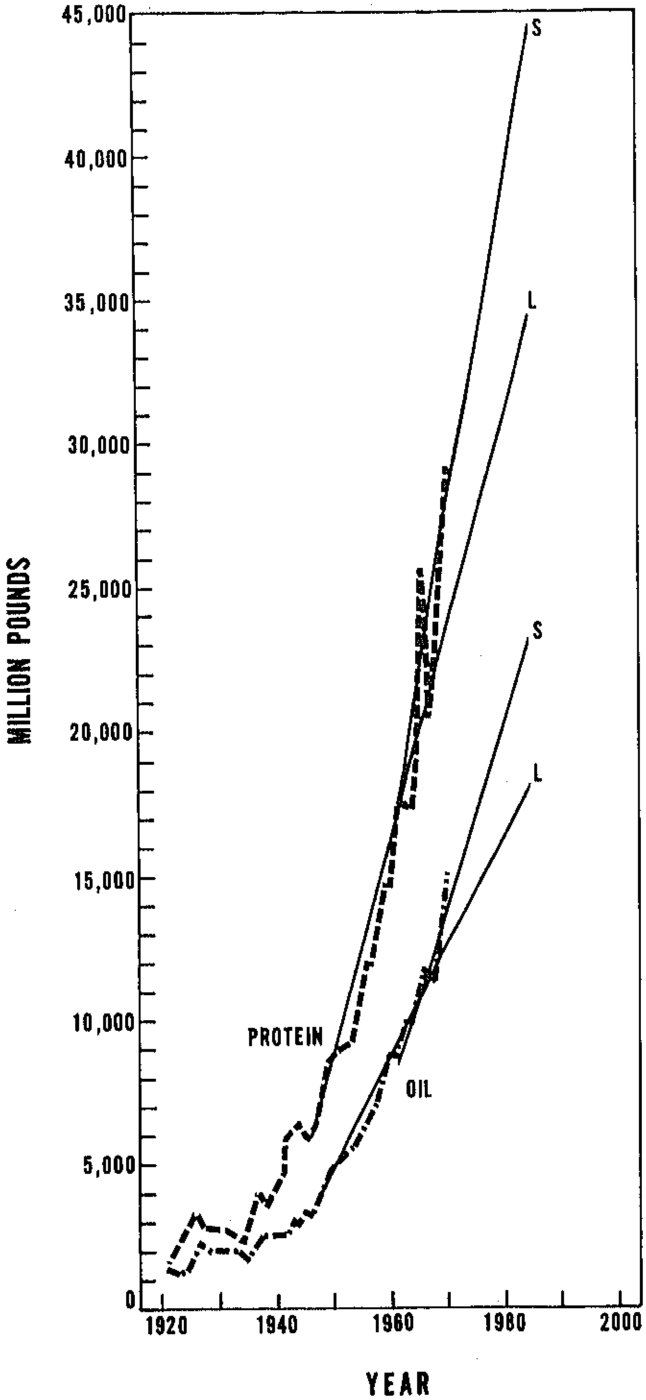

Figure 1.—U.S. production of edible vegetable oil compared to production of edible oilseed and fishmeal protein.

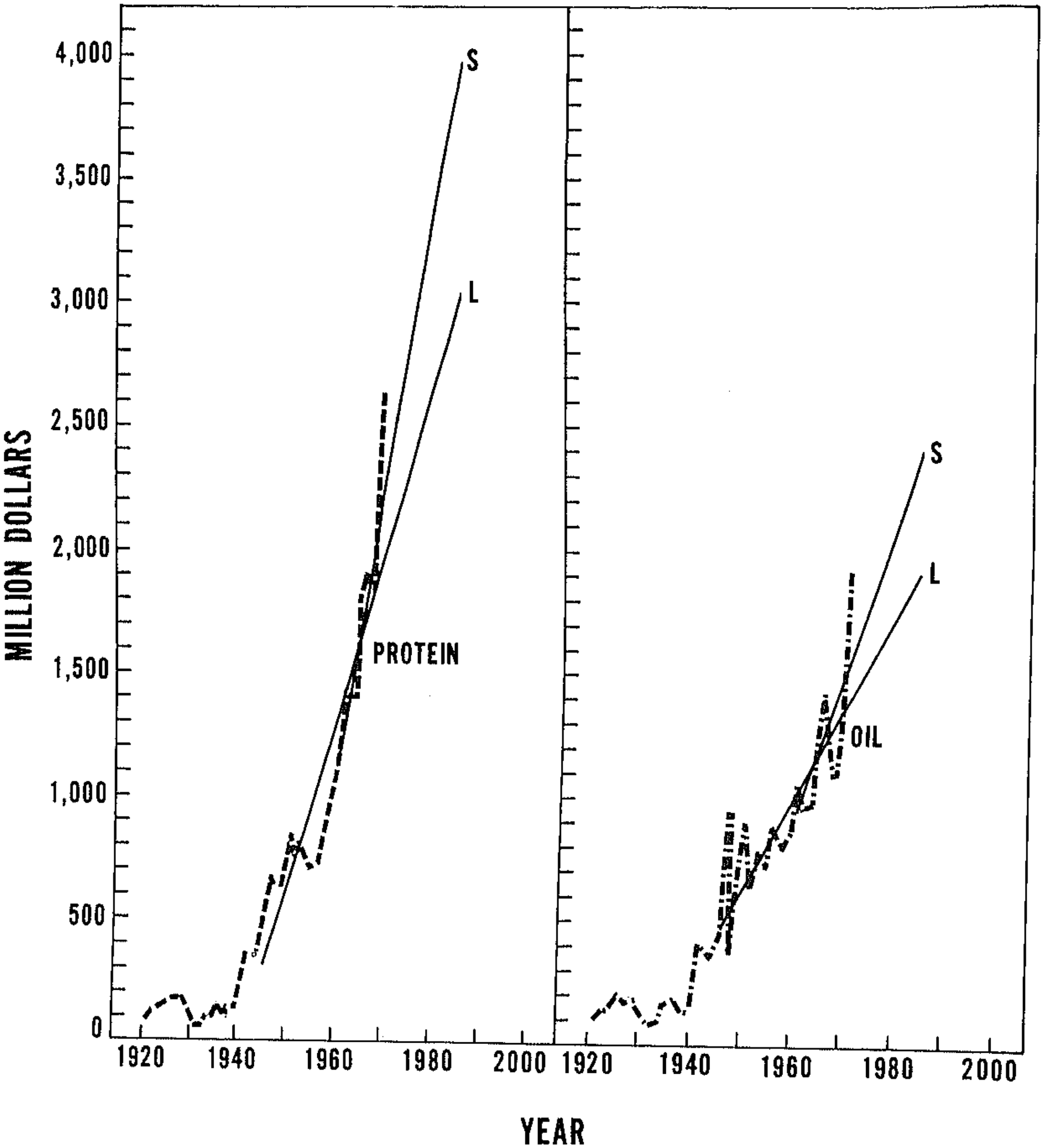

Figure 2.—Value of U.S. edible vegetable oil compared to value of edible oilseed and fishmeal protein.

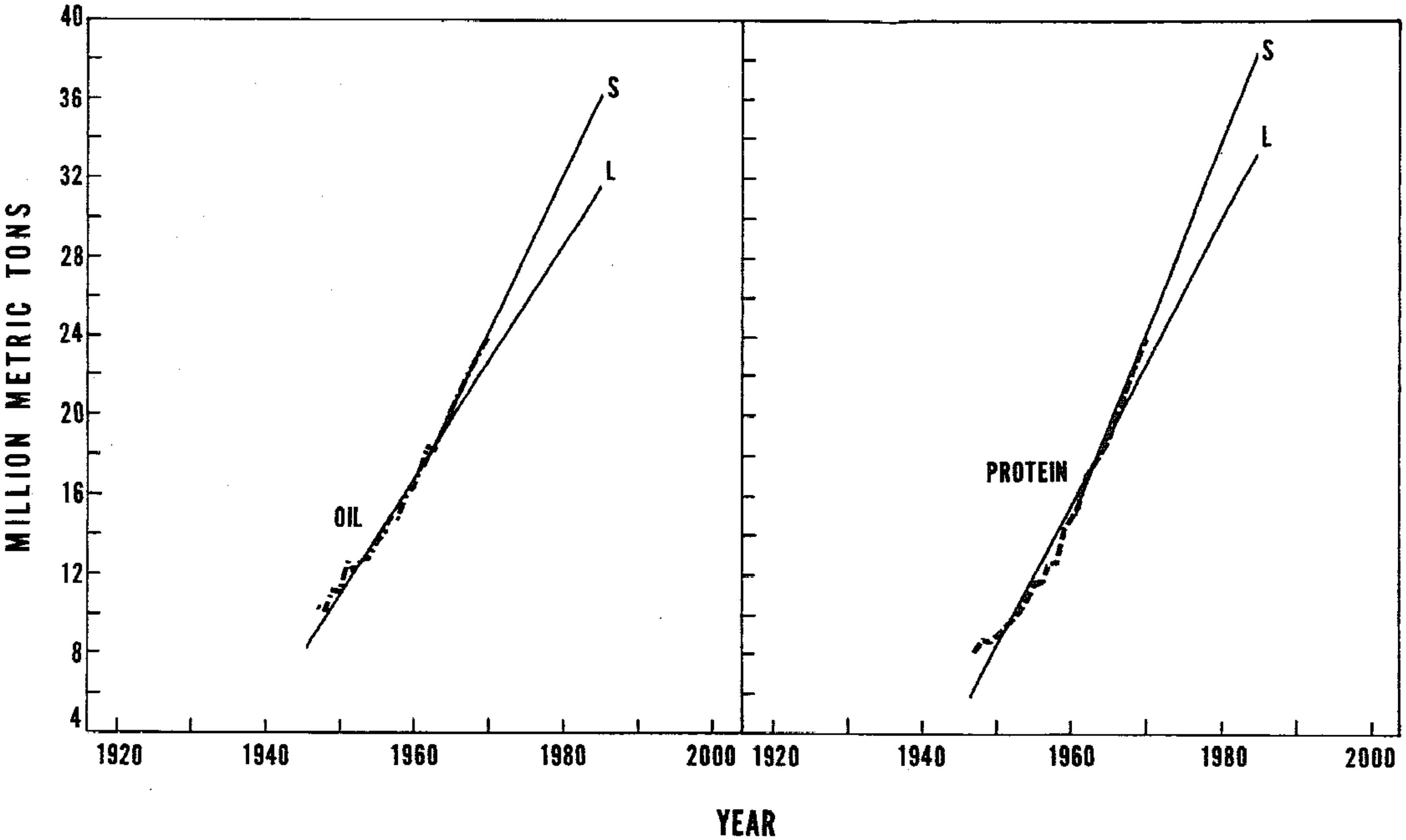

Figure 3.—World production of edible vegetable and palm oils compared to production of edible oilseed and fishmeal protein.

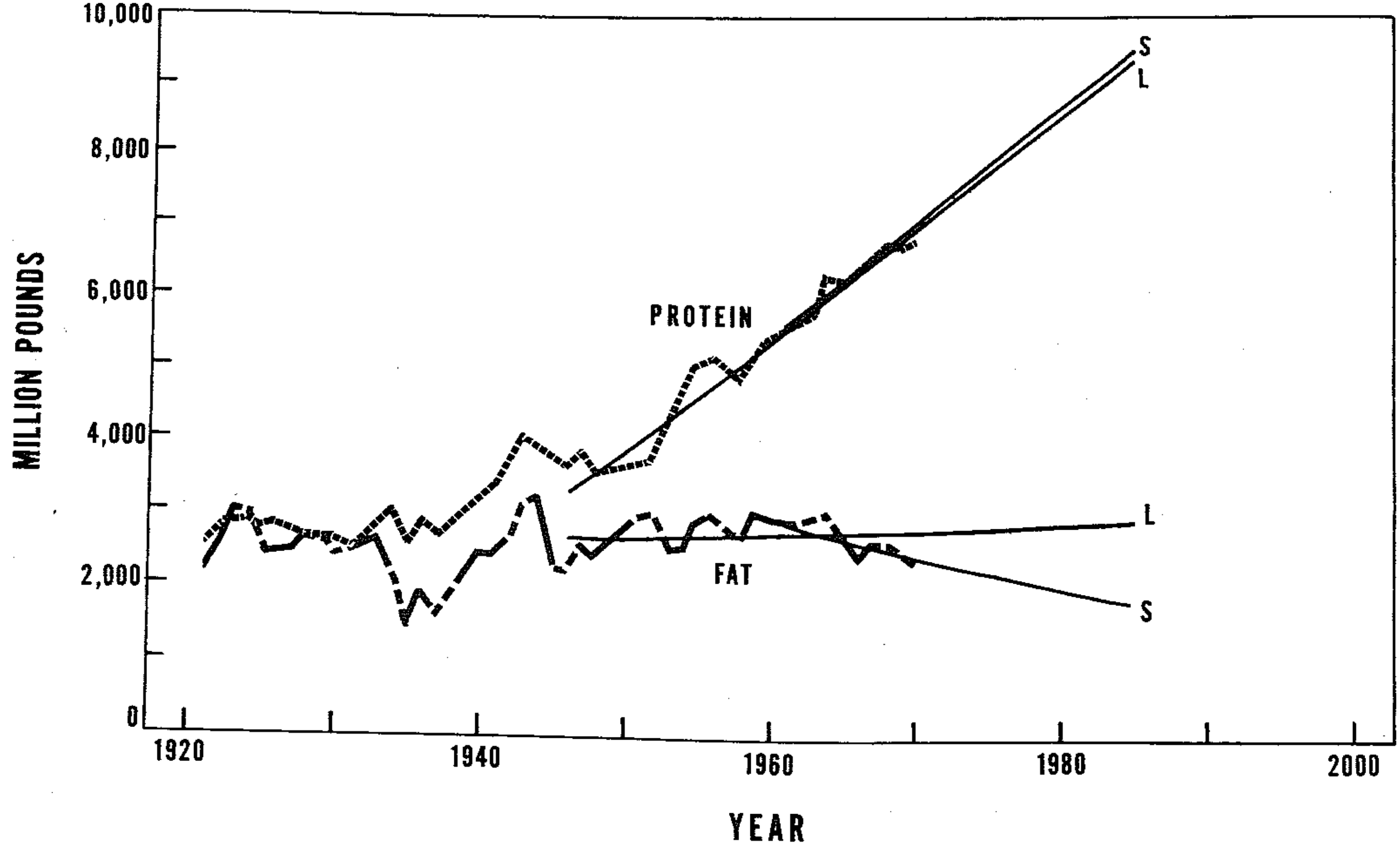

Figure 4.—U.S. production of edible red-meat animal fat compared to production of edible protein.

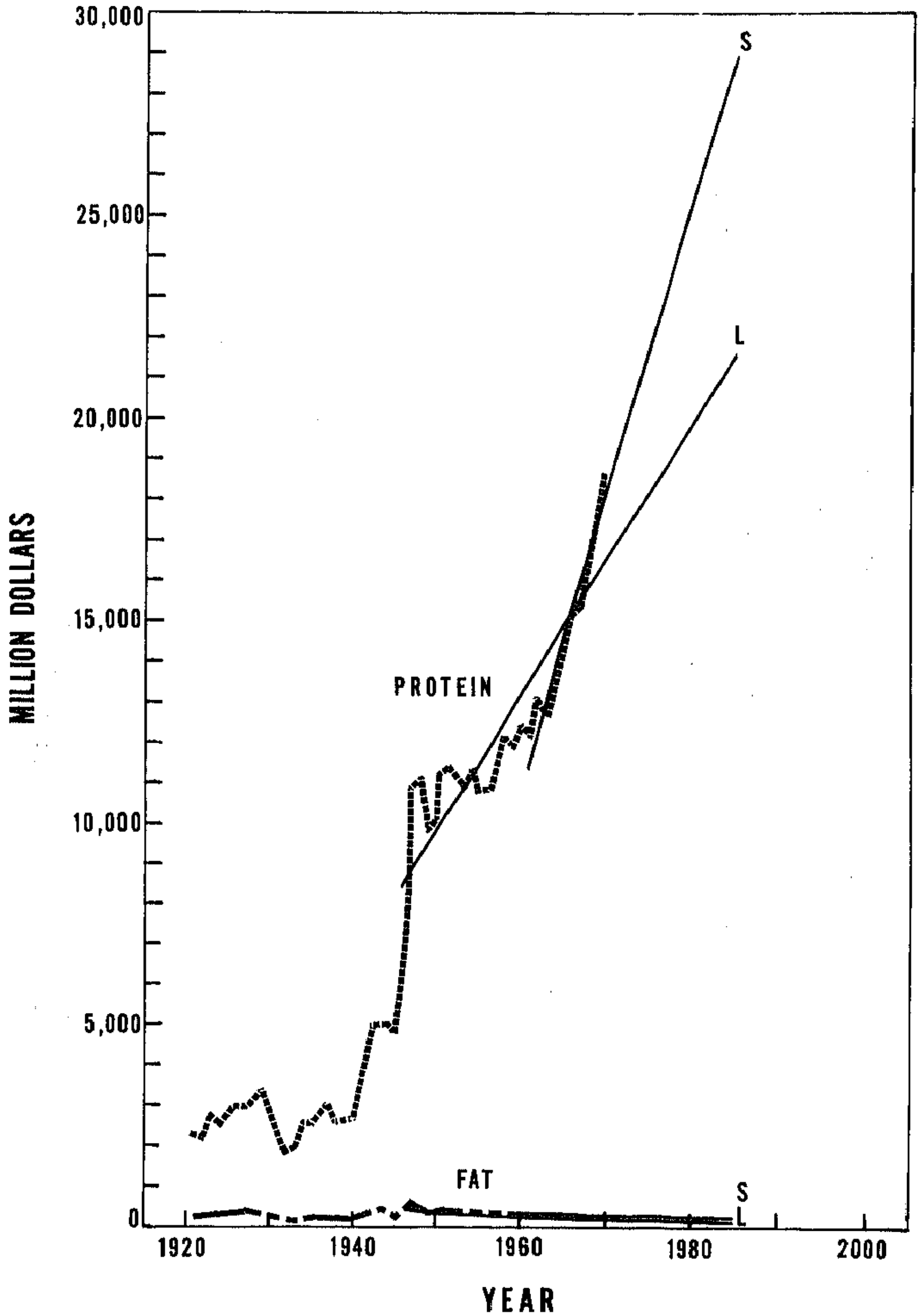

Figure 5.—Value of U.S. edible red-meat animal fat compared to value of edible protein.

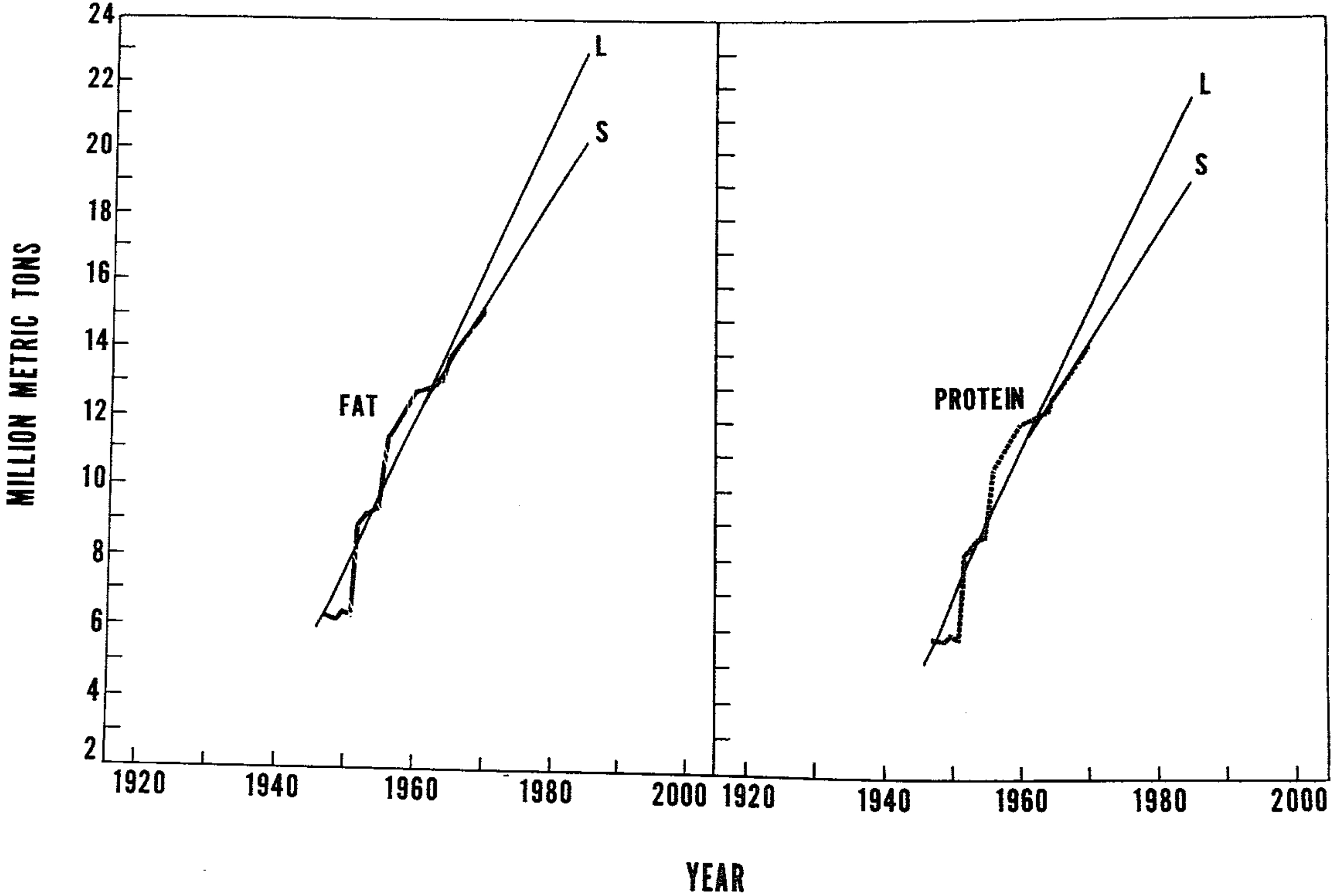

Figure 6.—World production of milk fat compared to world production of milk protein.

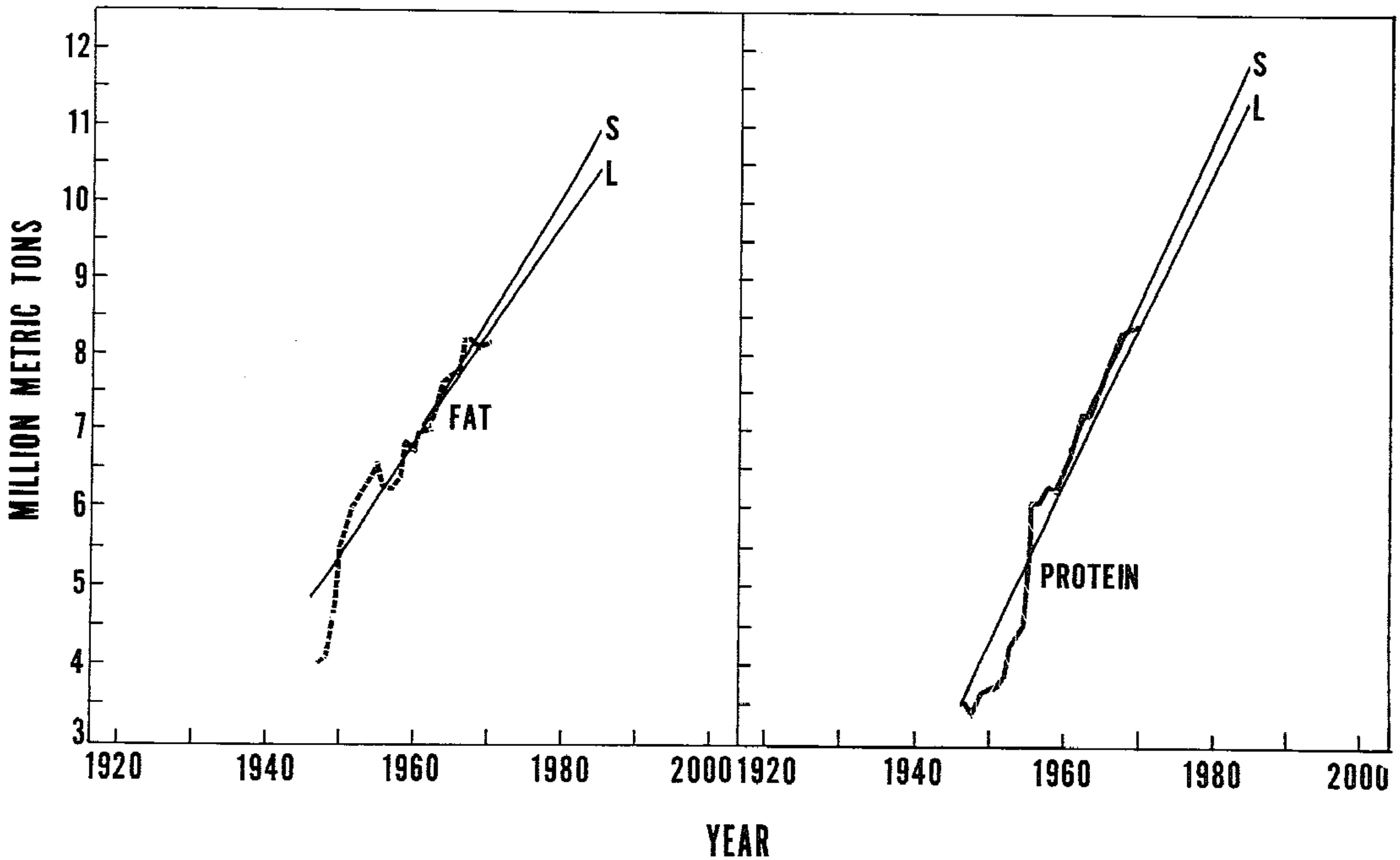

Figure 7.—World production of red-meat animal fat compared to world production of protein.

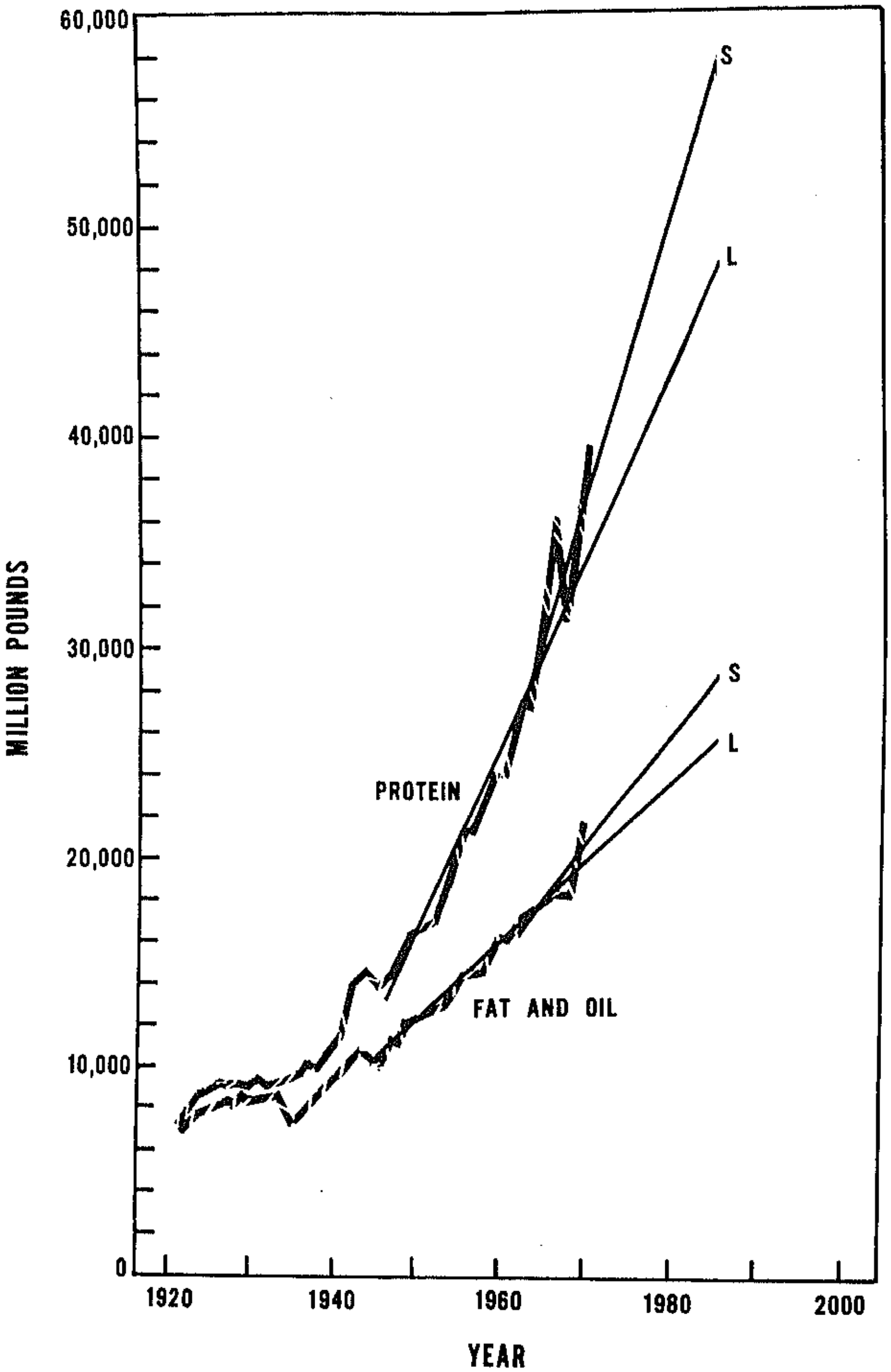

Figure 8.–U.S. production of edible fat and oil compared to edible protein. Includes red meat, milk, oilseed, and fishme

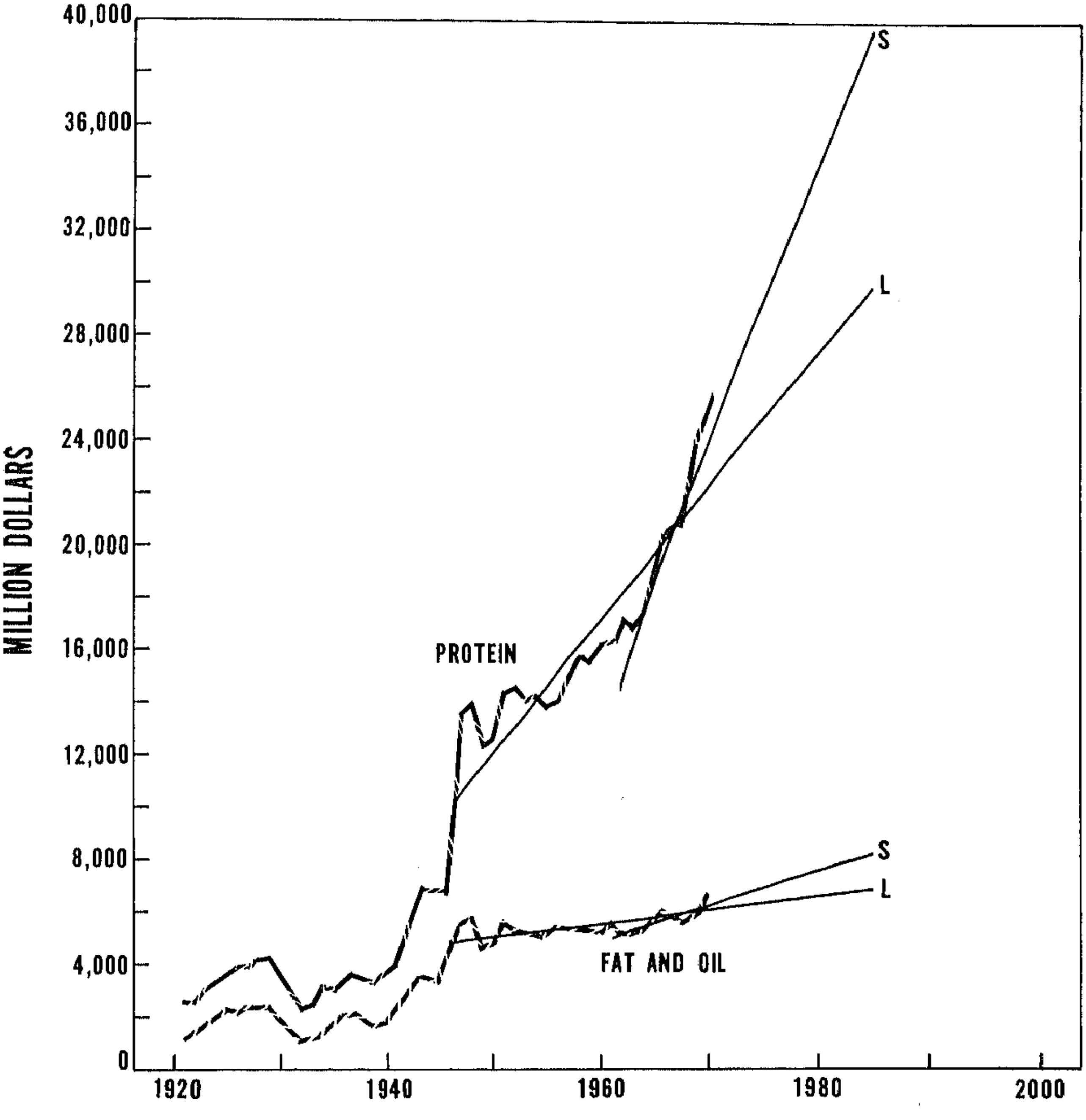

Figure 9.—Value of U.S. edible fat and oil compared to edible protein. Includes red meat, milk, oilseed, and fishmeal.

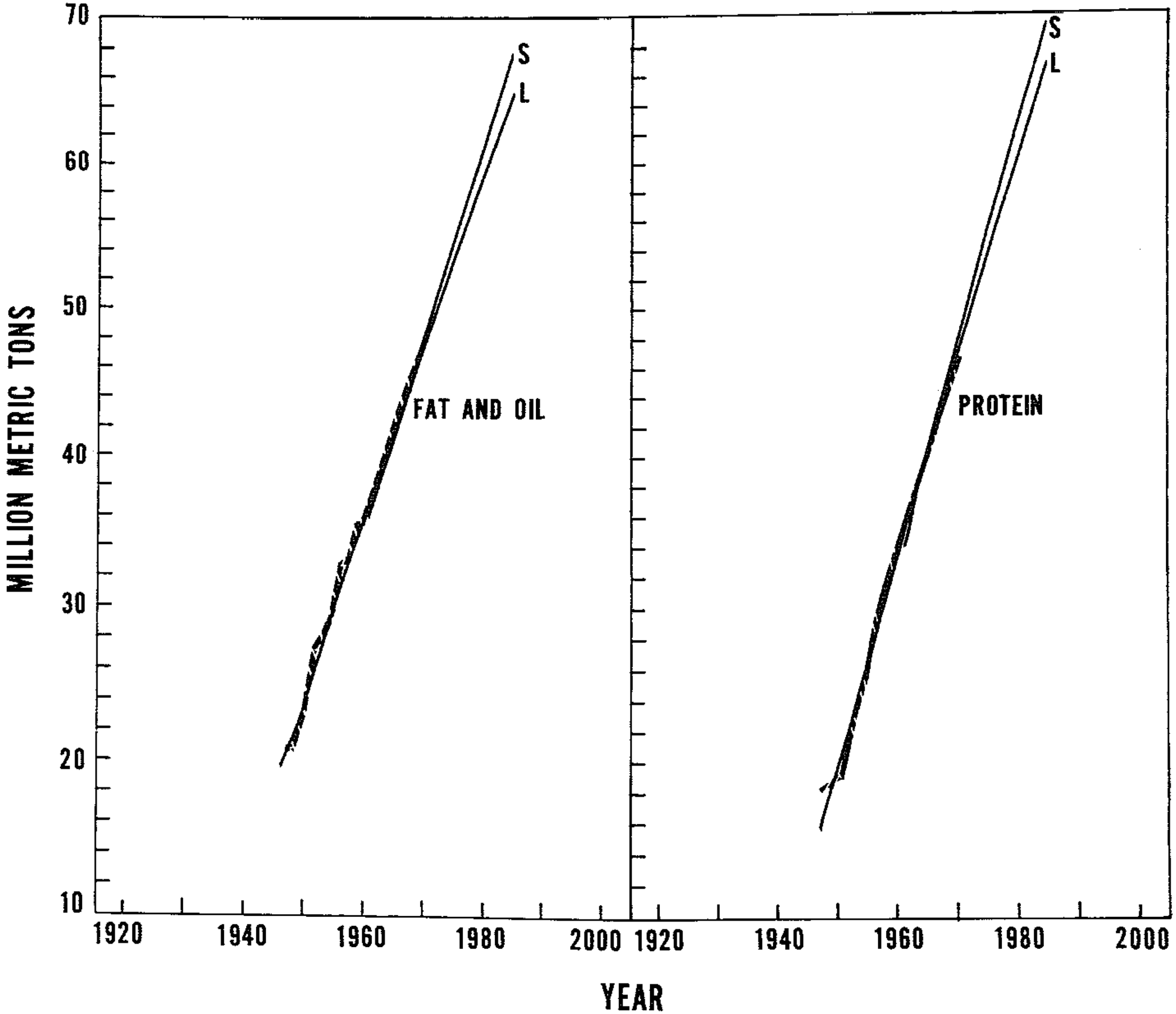

Figure 10.—World production of fat and oil compared to edible protein. Includes red meat, milk, oilseed, and fishmeal.

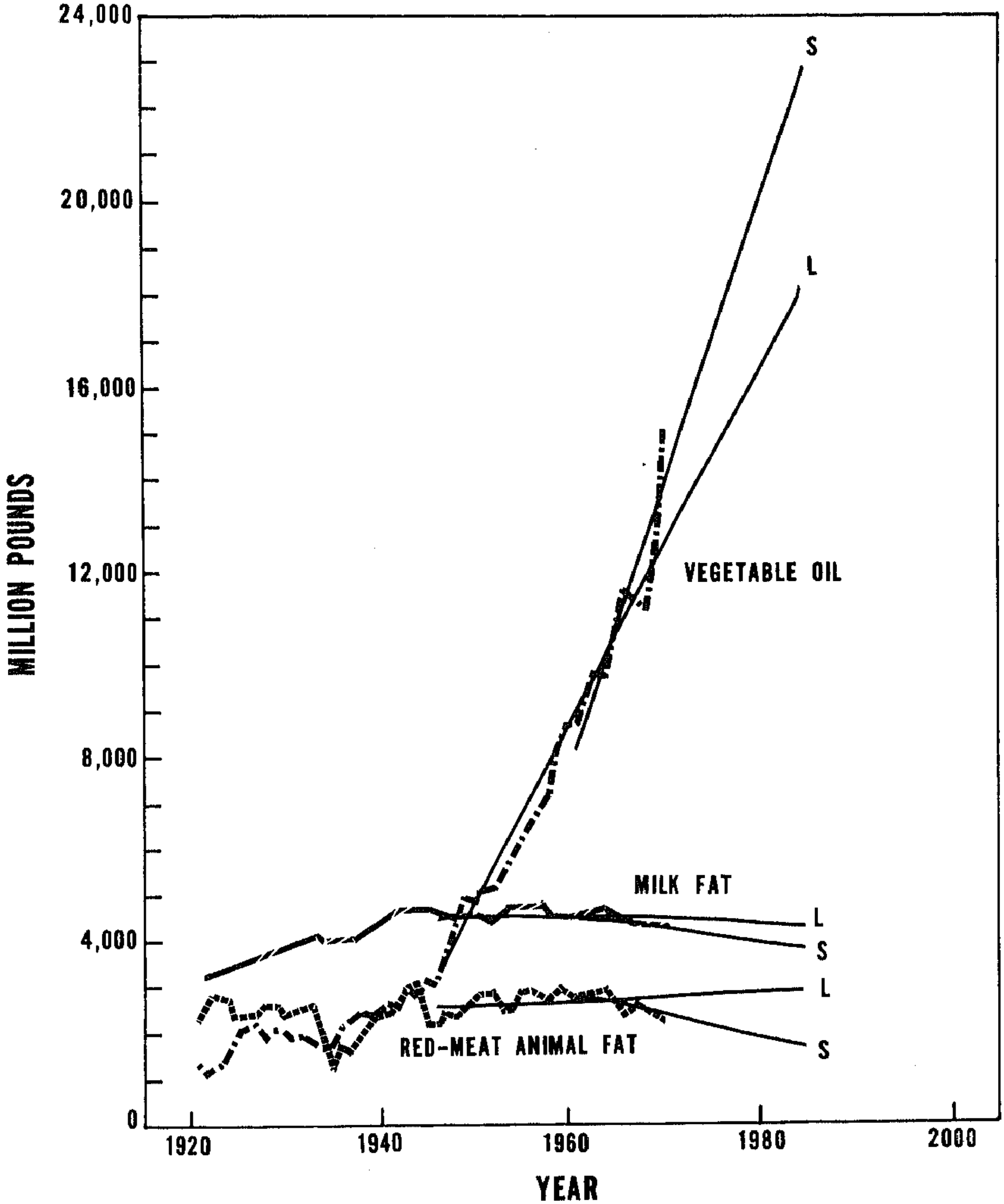

Figure 11.—U.S. production of vegetable oil, milk fat, and red-meat animal fat, by type.

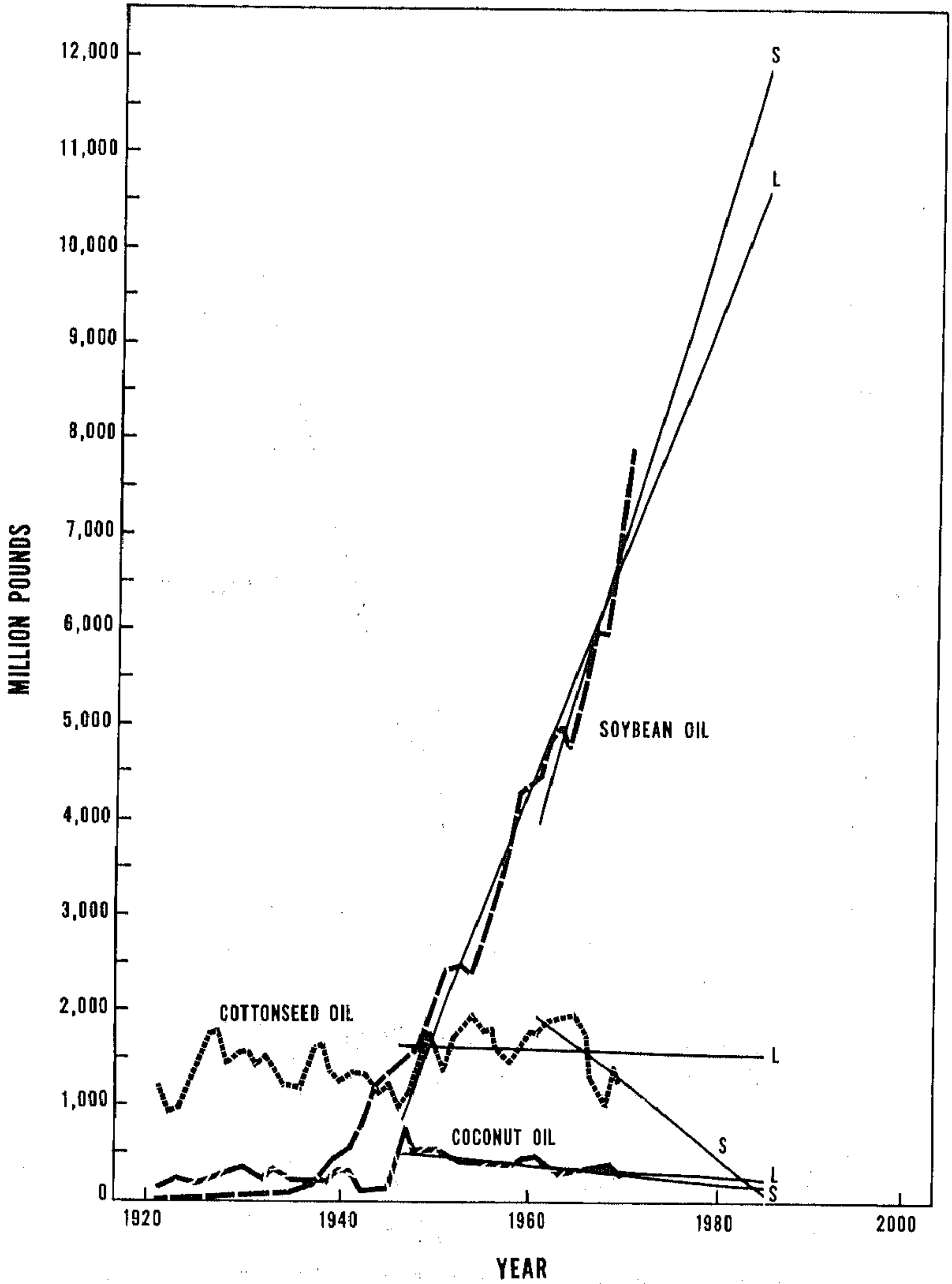

Figure 12.—U.S. production of soybean, cottonseed, and coconut oils.

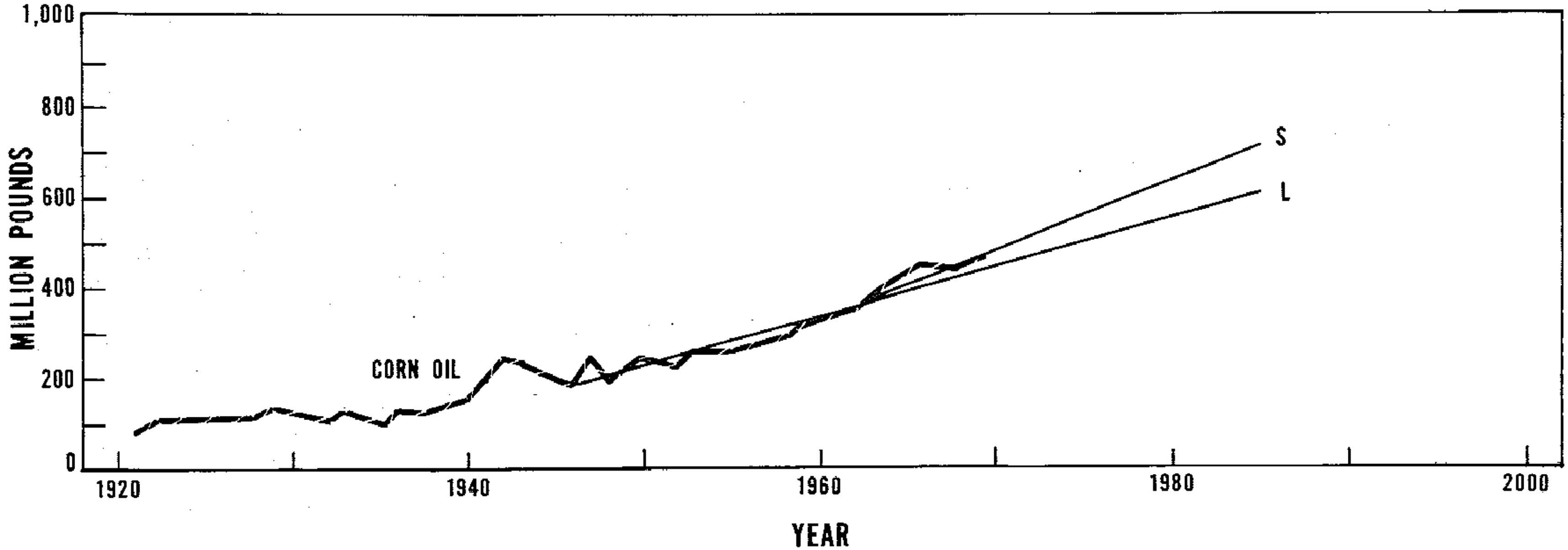

Figure 13.—U.S. production of corn oil.

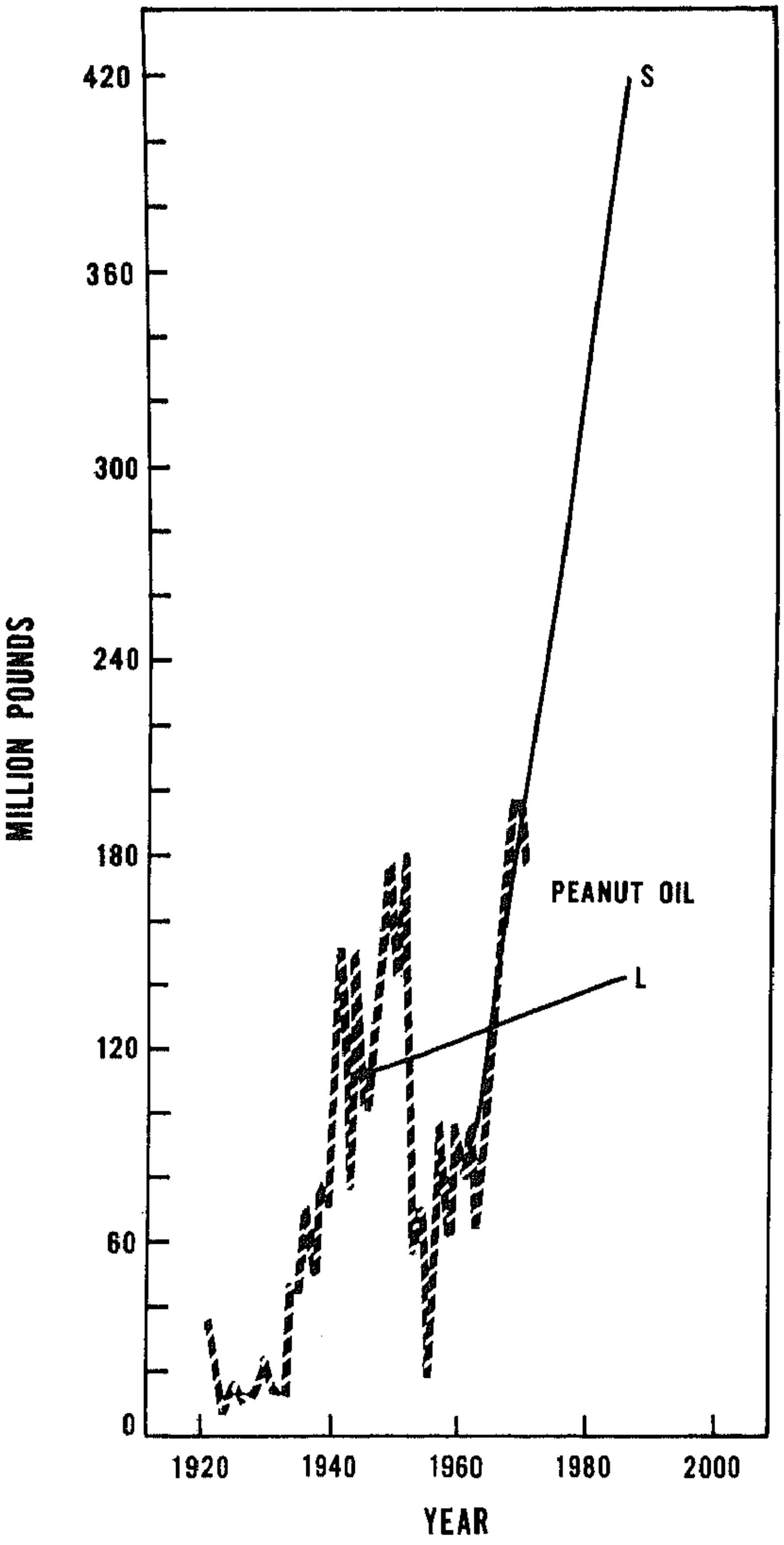

Figure 14.—U.S. production of peanut oil.

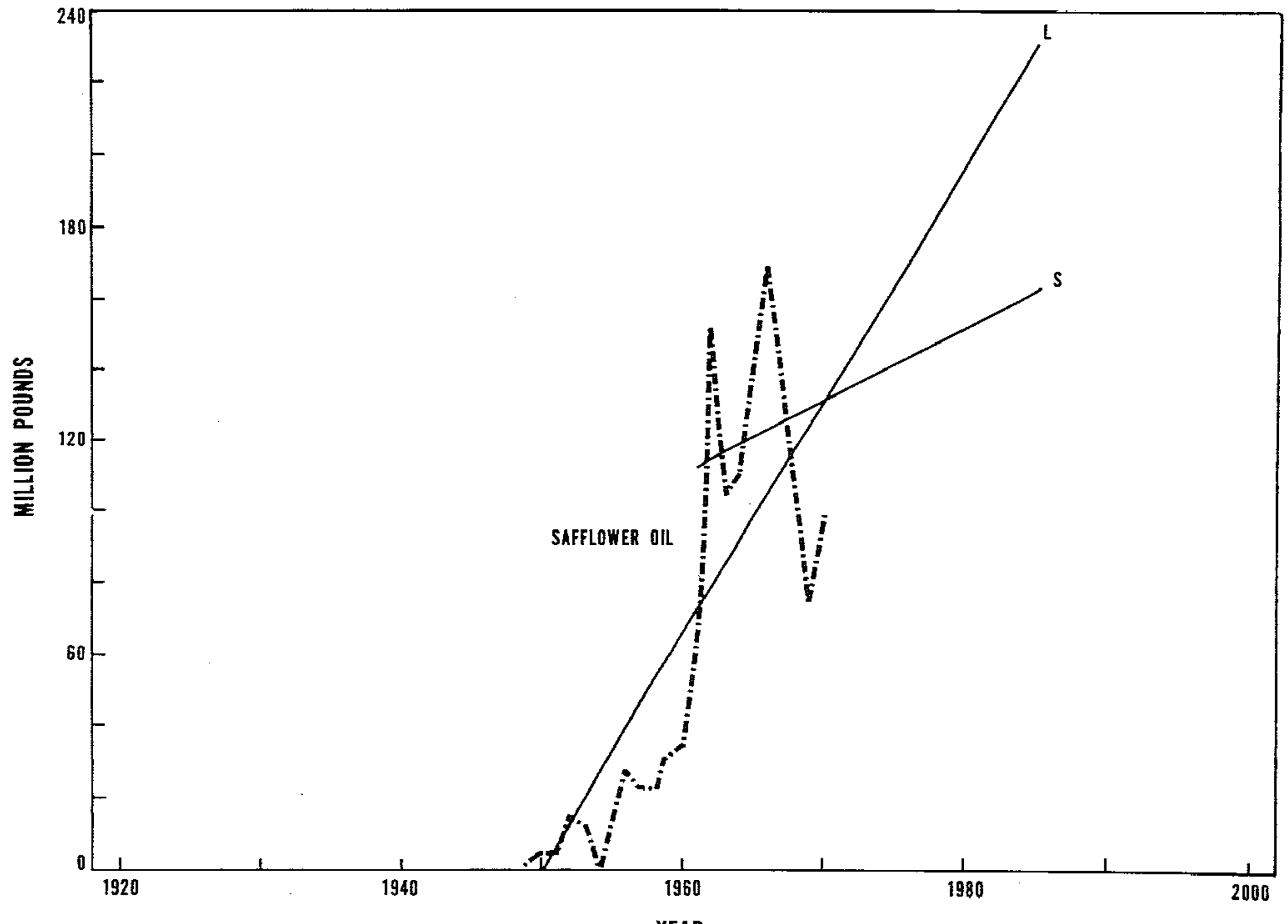

Figure 15.—U.S. production of safflower oil.

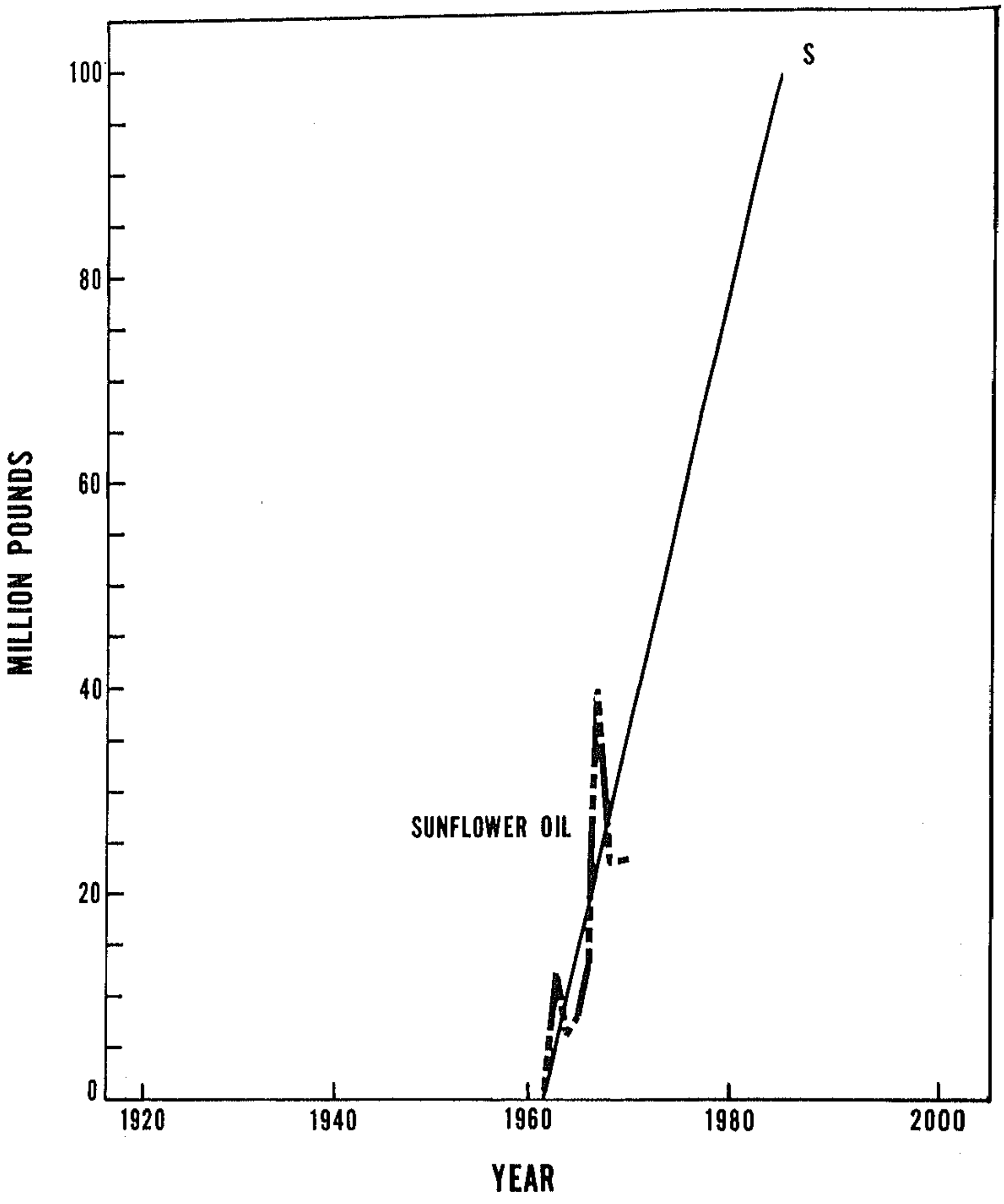

Figure 16.—U.S. production of sunflower oil.

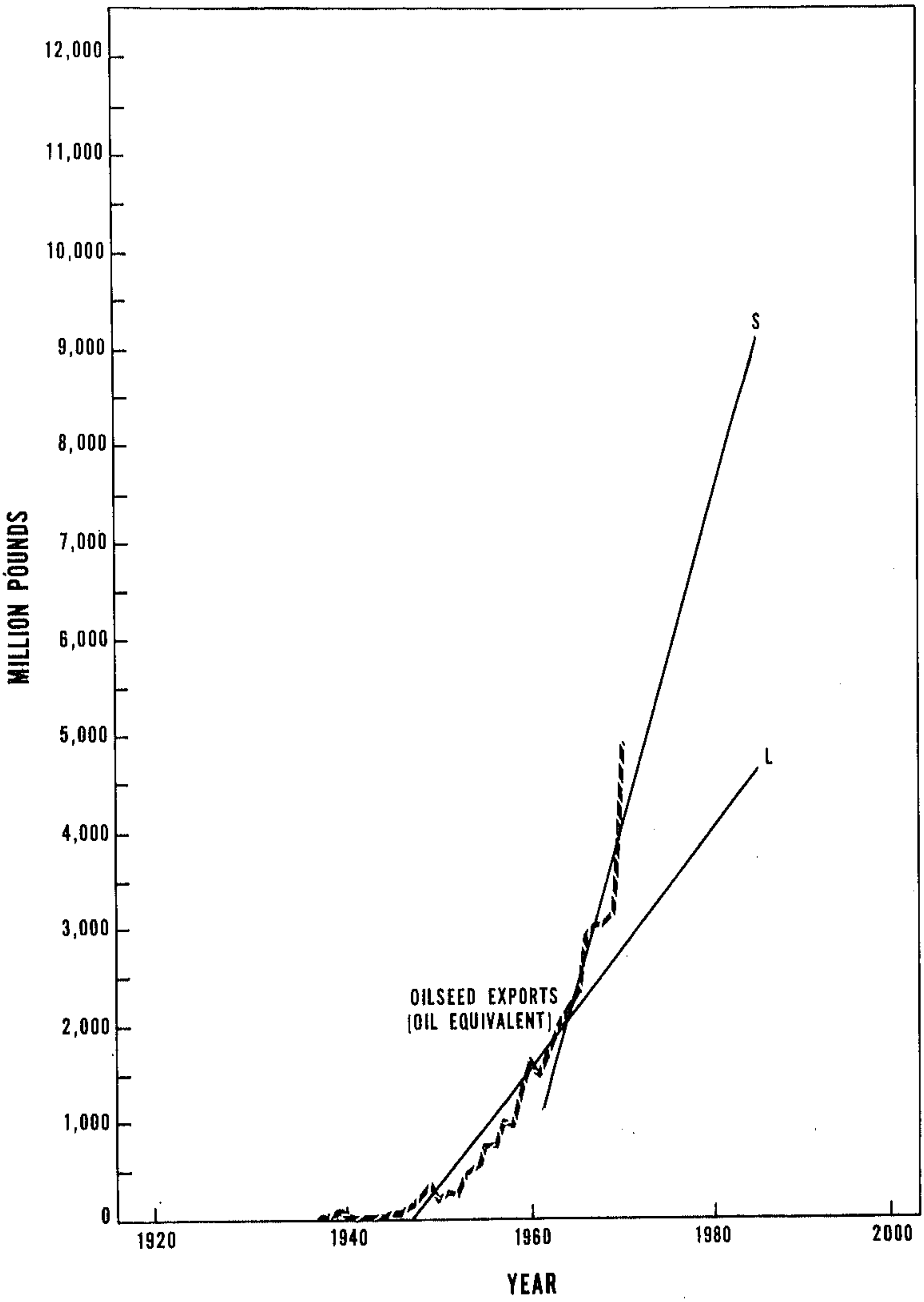

Figure 17.—U.S. production of edible oilseed exports (oil equivalent).

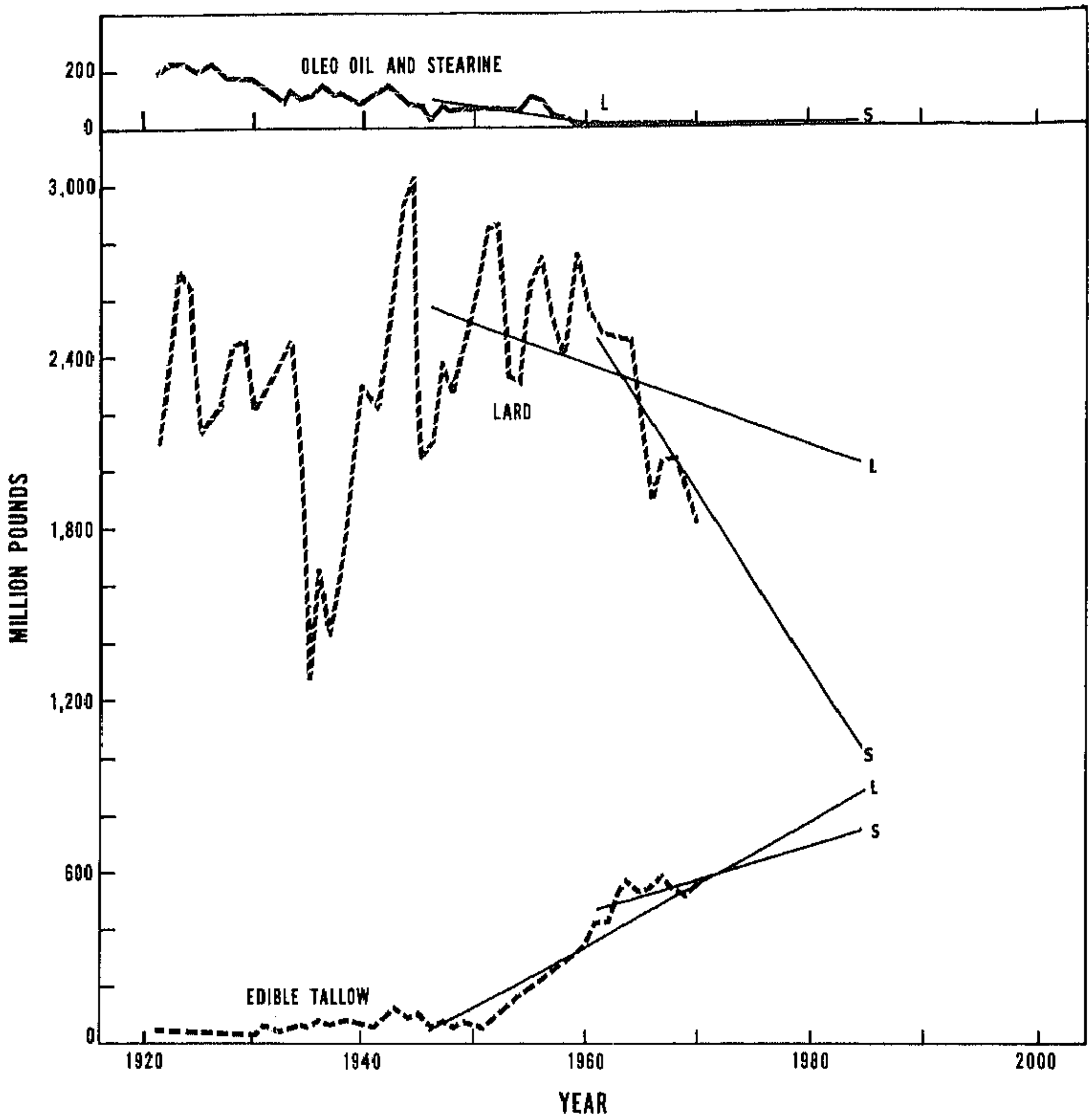

Figure 18.—U.S. production of oleo oil, stearine, lard, and edible tallow.

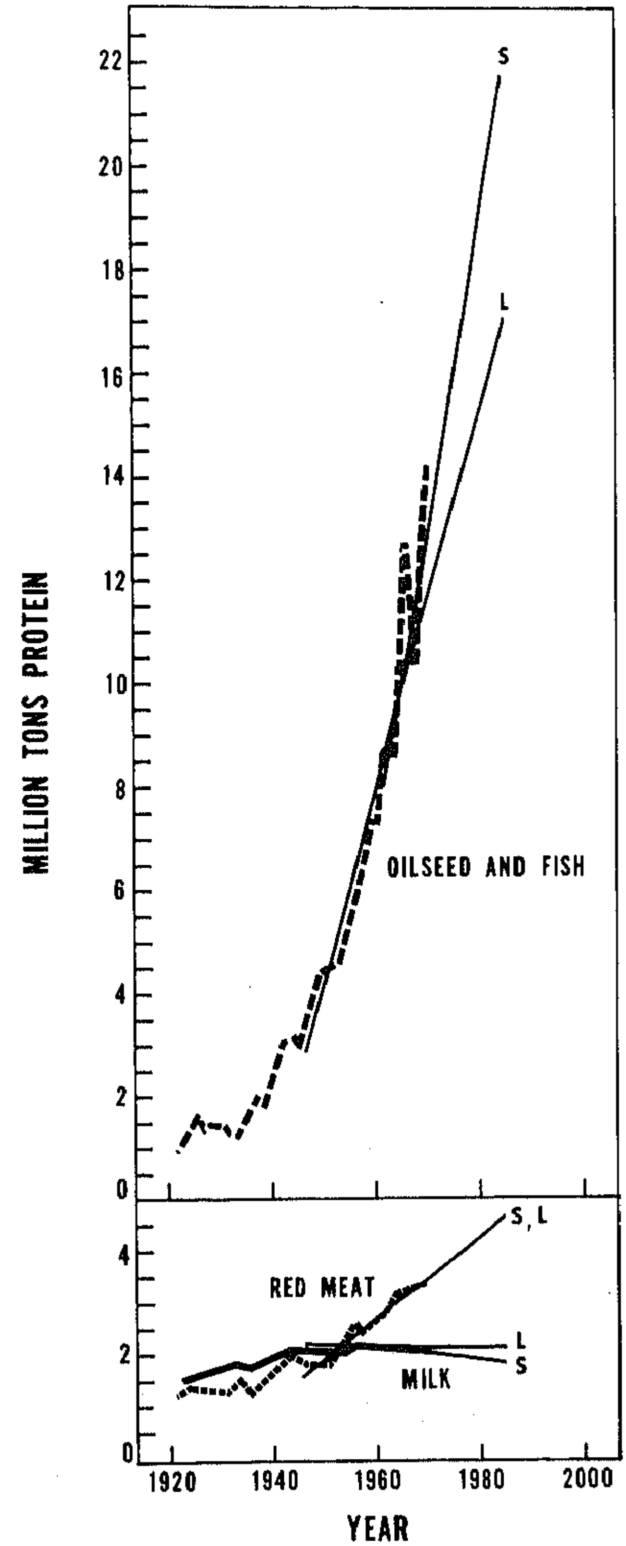

Figure 19.—U.S. production of edible oilseed, fishmeal, red-meat, and milk proteins, by type.

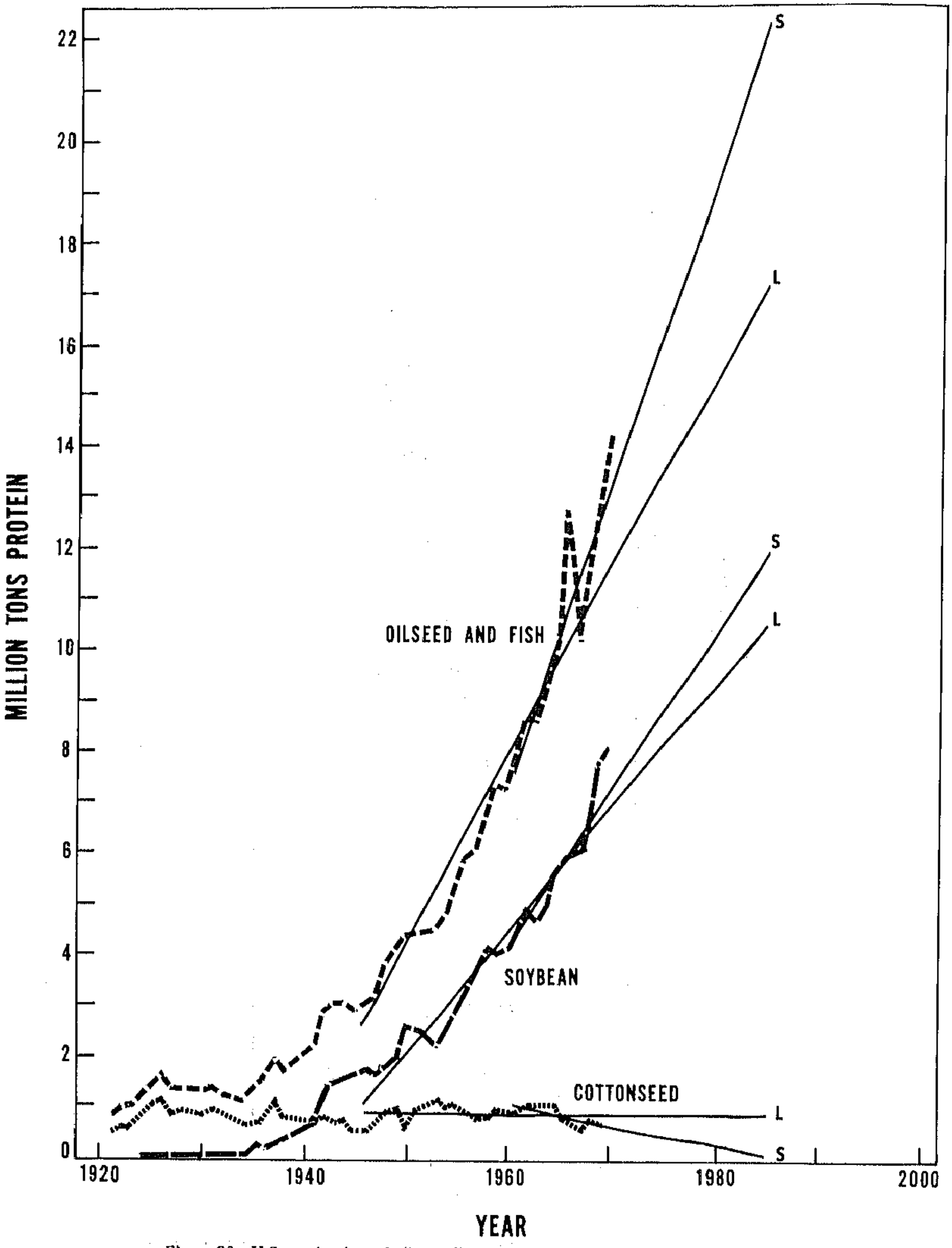

Figure 20.—U.S. production of oilseed, fishmeal, soybean, and cottonseed proteins.

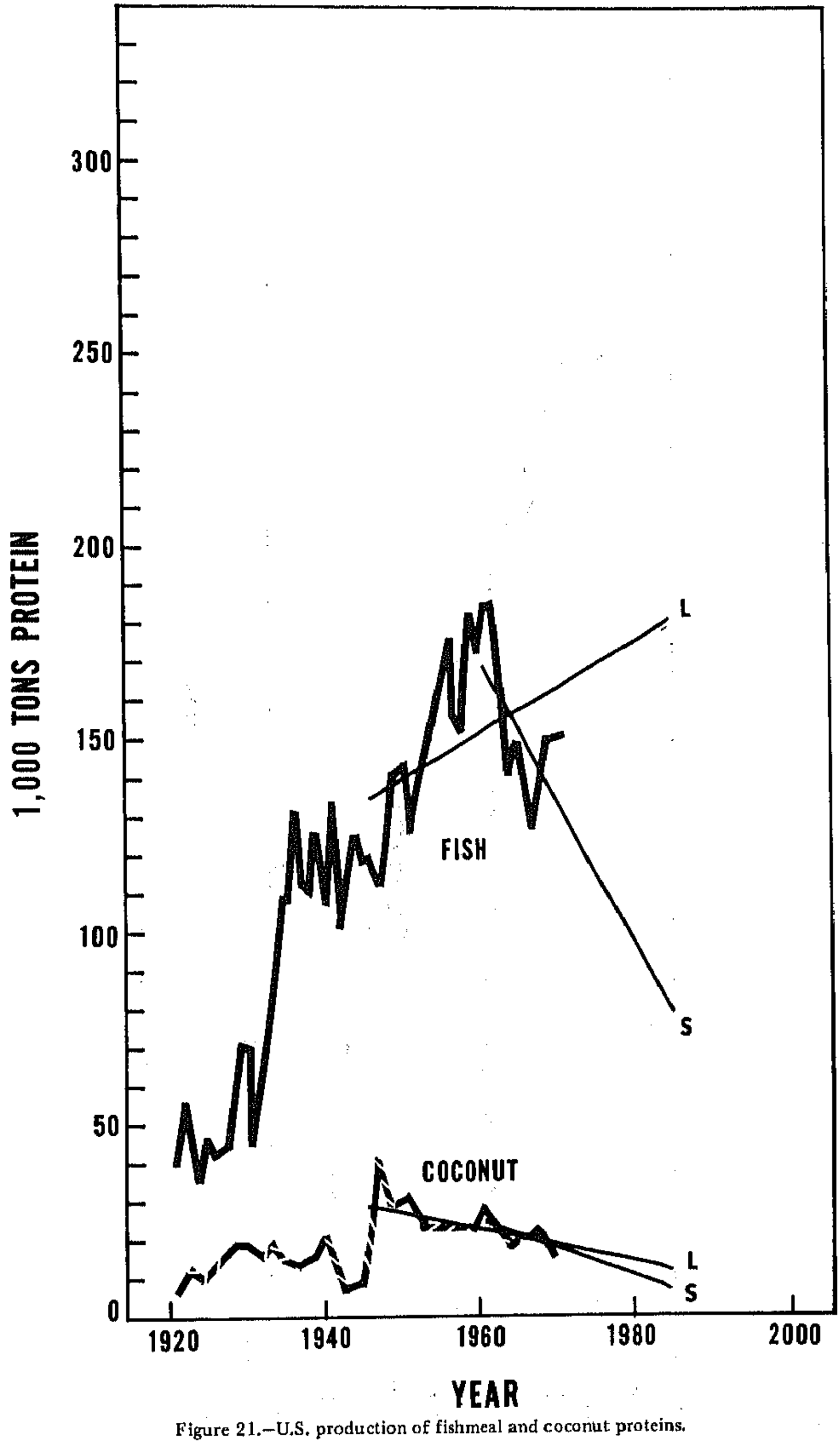

Figure 21.—U.S. production of fishmeal and coconut proteins.

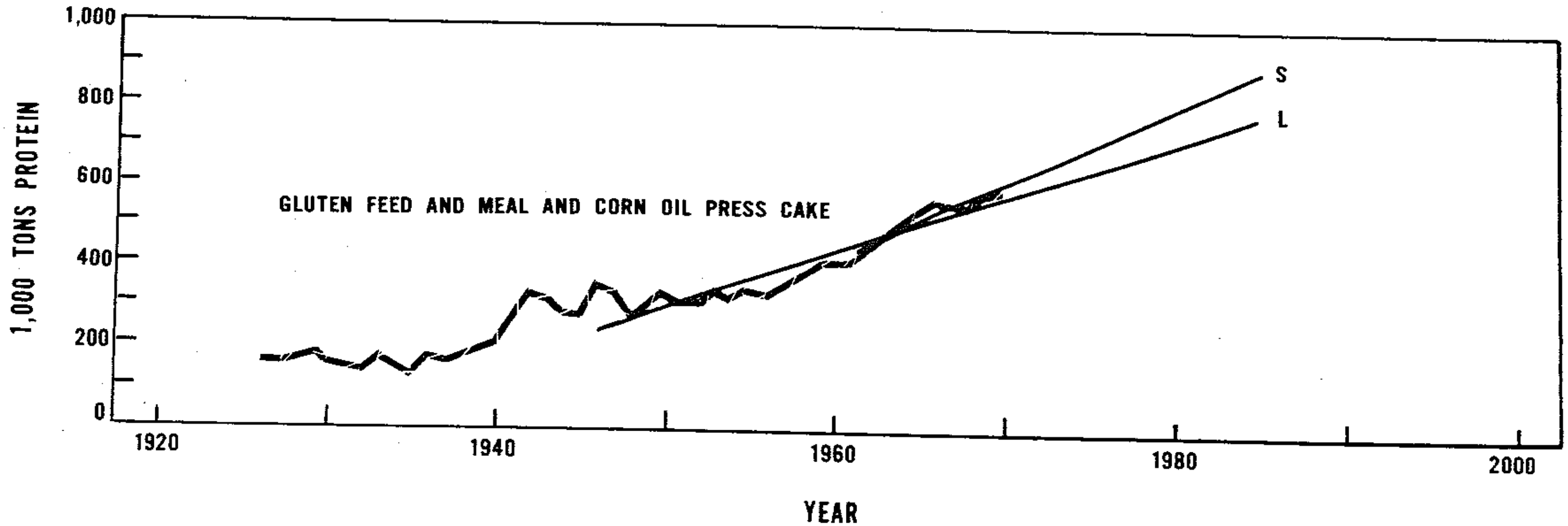

Figure 22.—U.S. production of gluten feed, gluten meal, and corn oil press cake proteins.

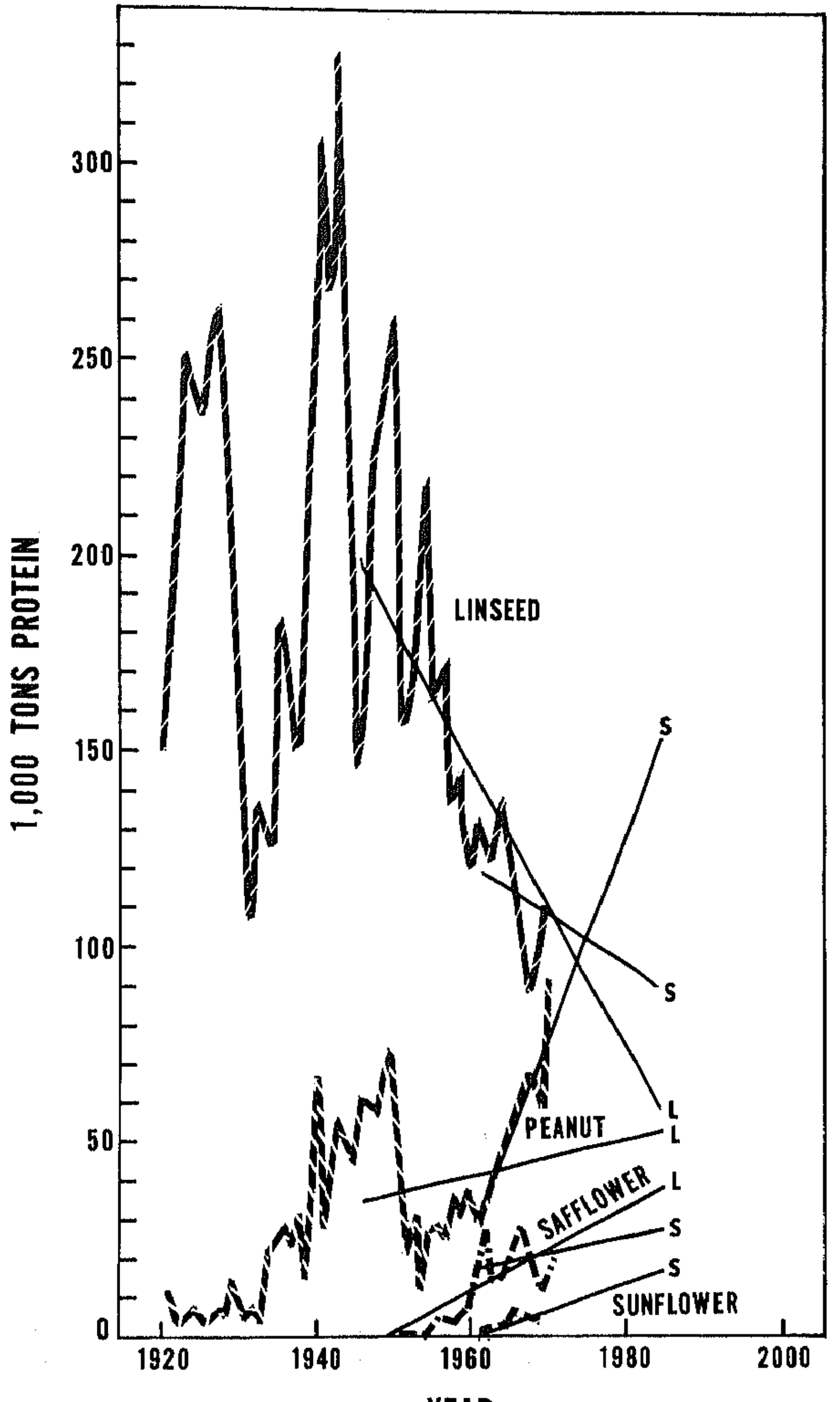

Figure 23.—U.S. production of linseed, peanut, safflower, and sunflower proteins.

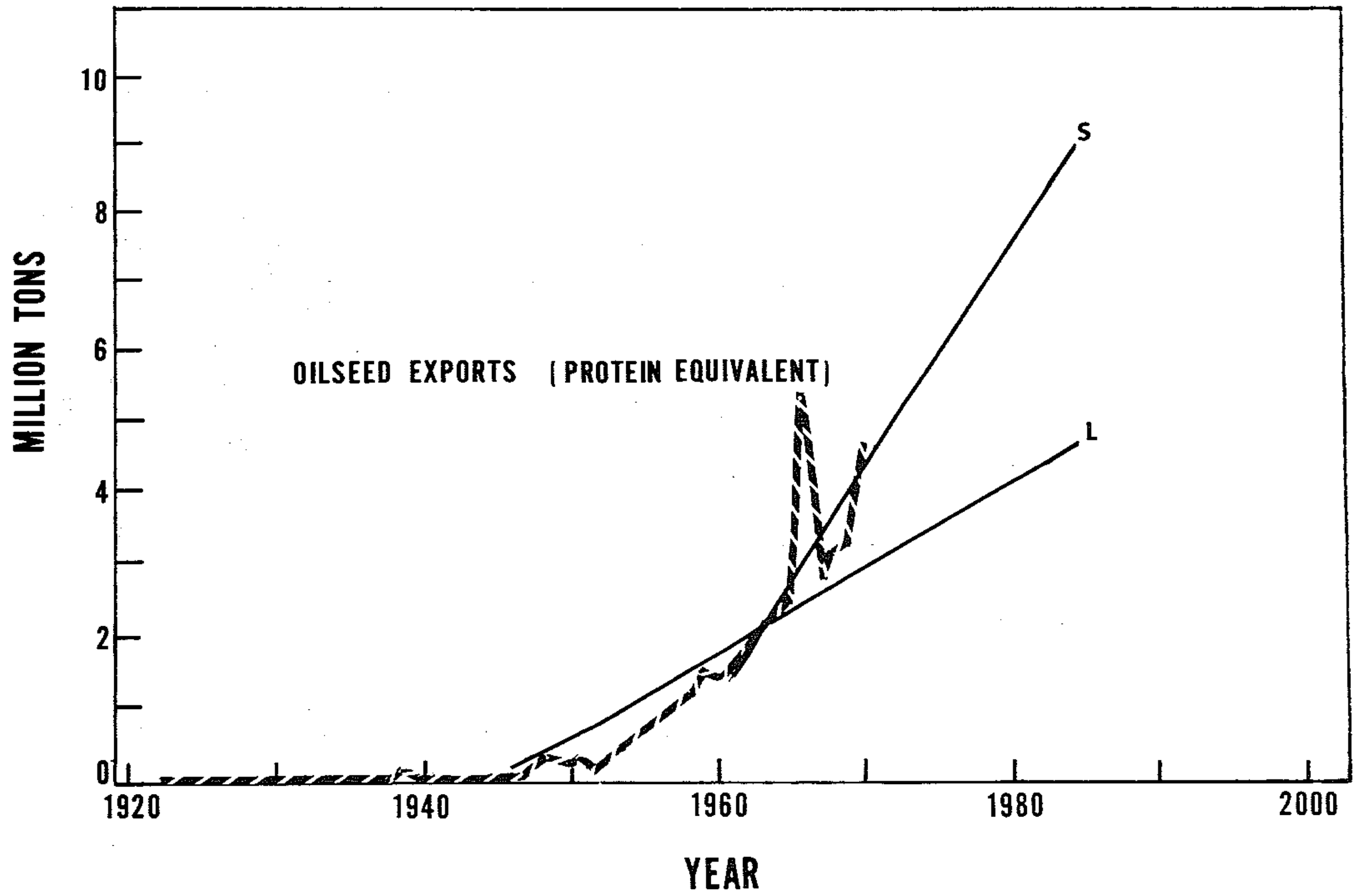

Figure 24.—U.S. production of oilseed exports (protein equivalent).

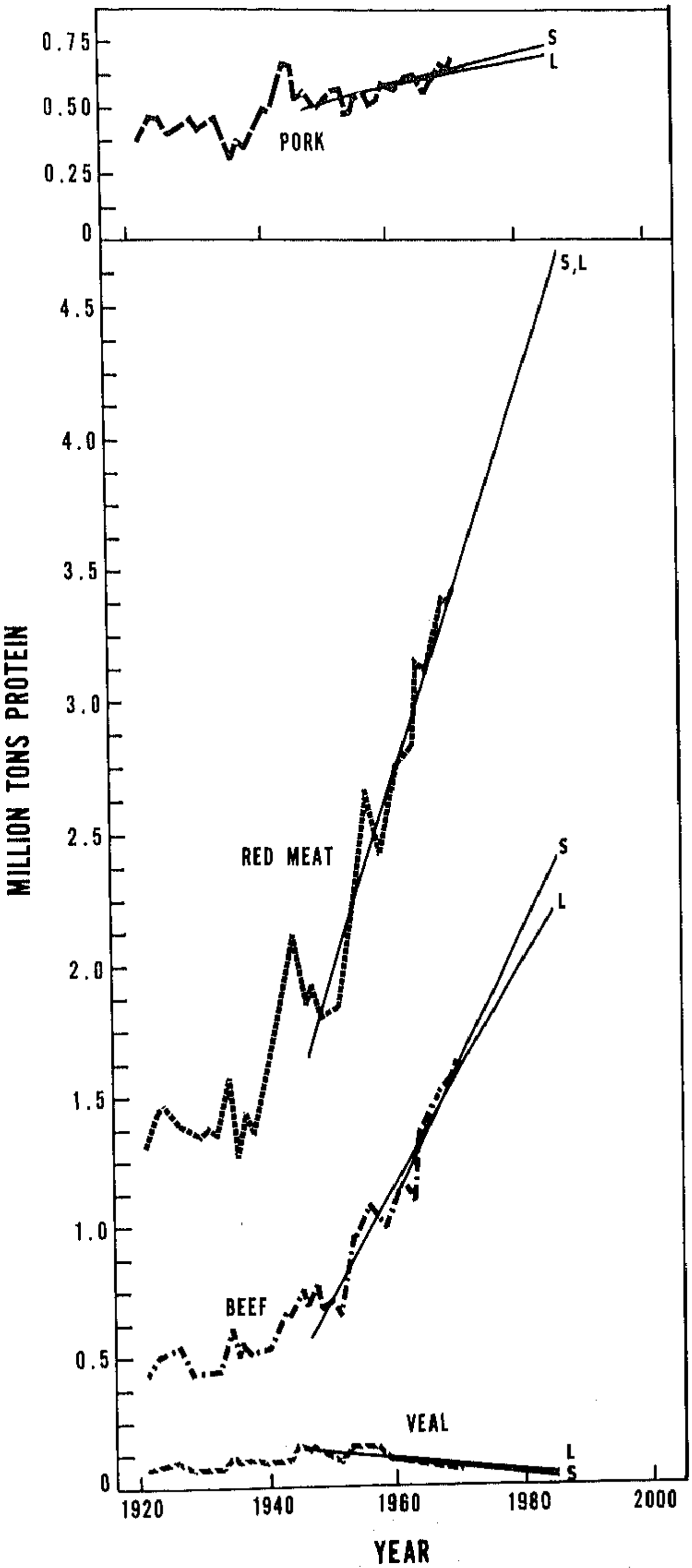

Figure 25.—U.S. production of red meat, beef, veal, and pork proteins.

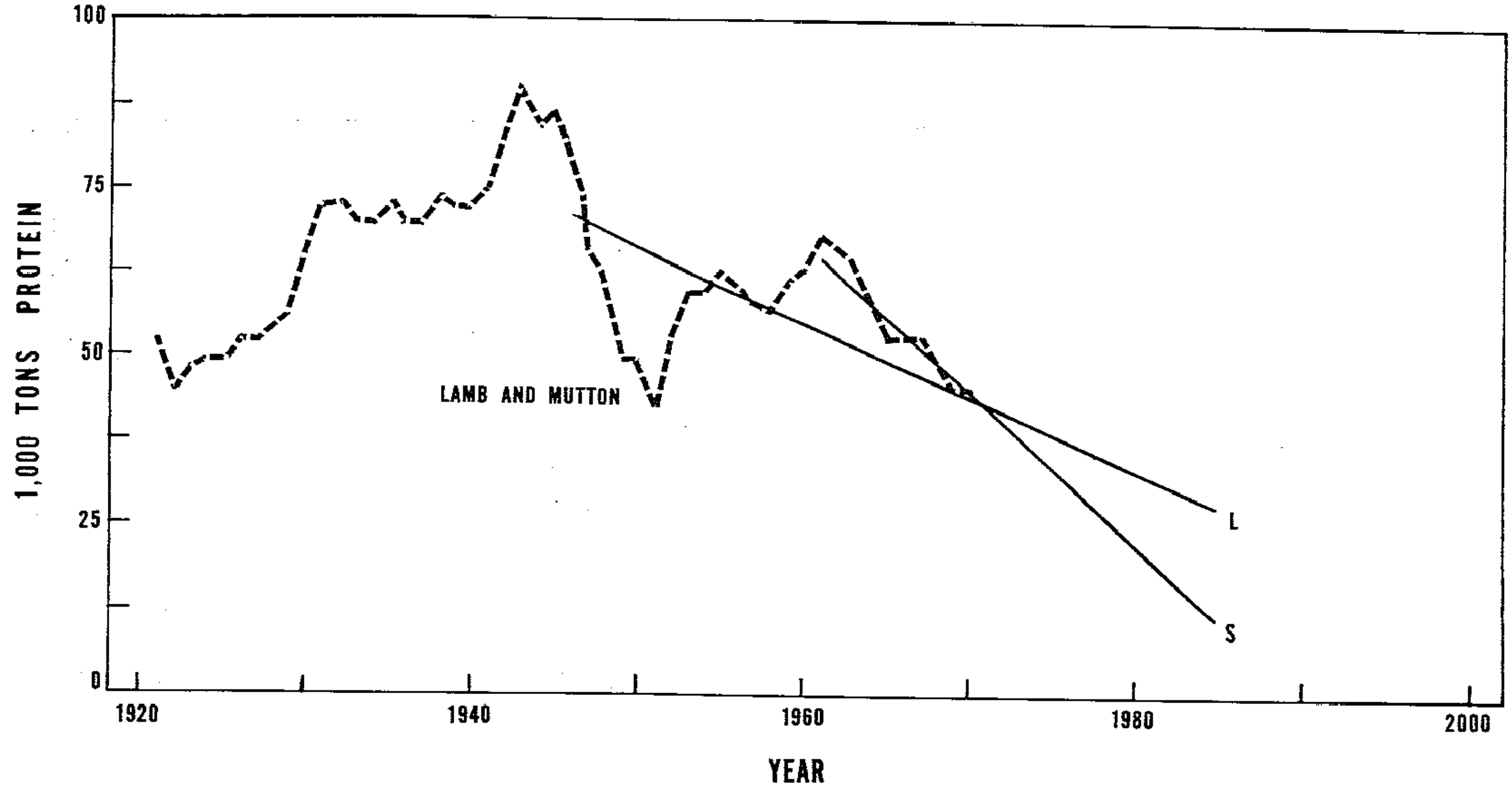

Figure 26.—U.S. production of lamb and mutton proteins.

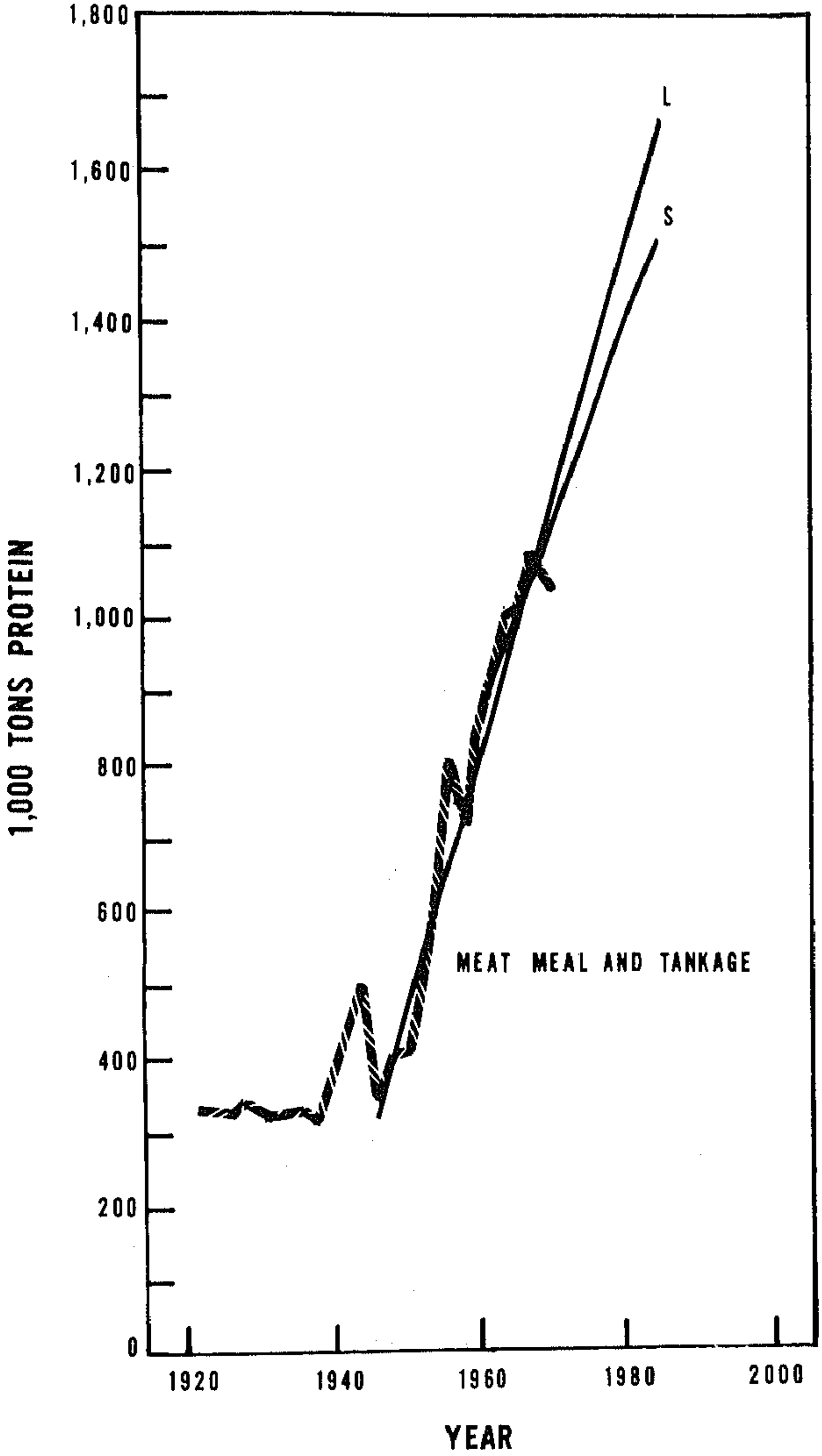

Figure 27.—U.S. production of meat-meal and tankage proteins.

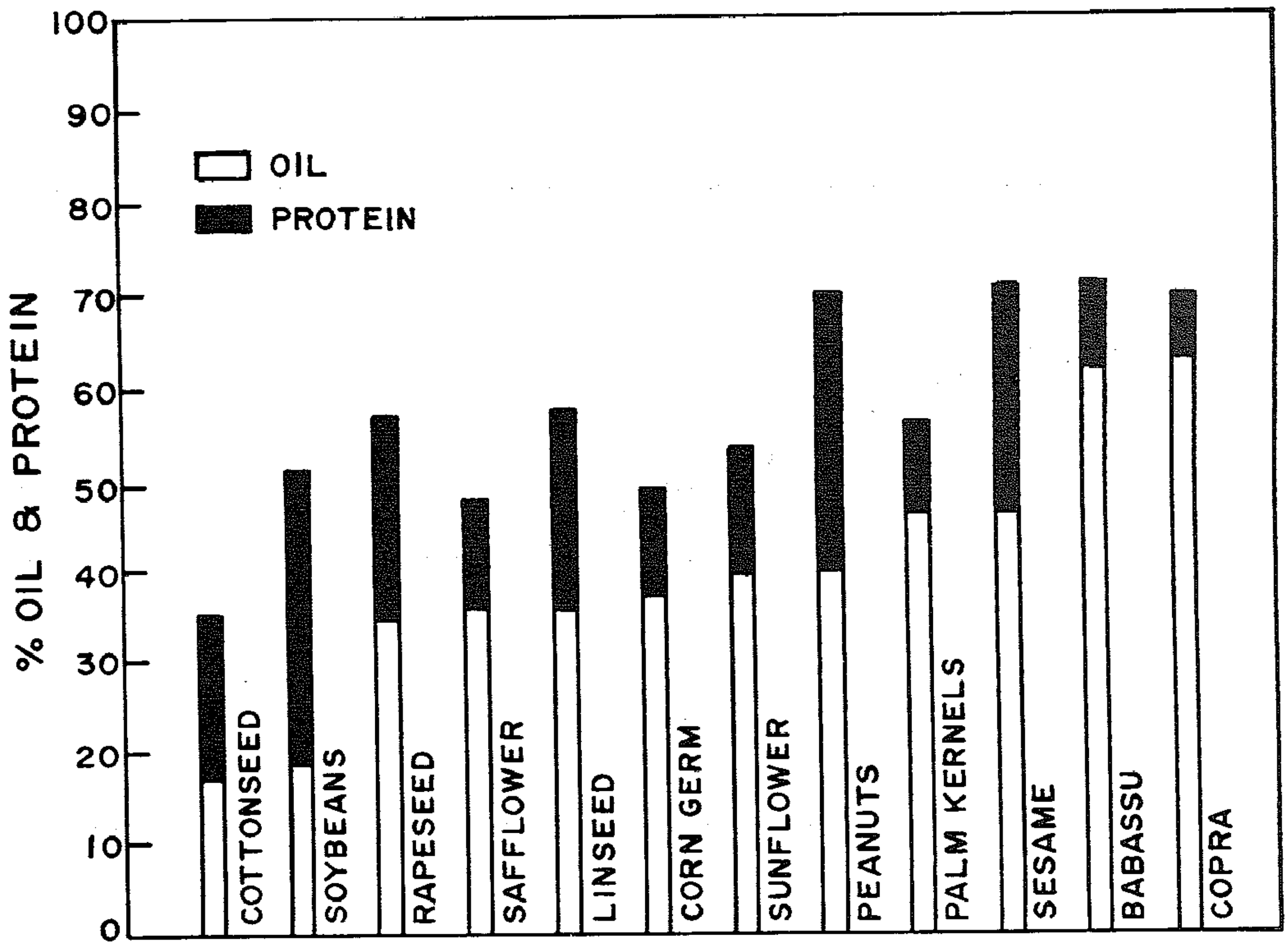

Figure 28.—Processing yield of oil and protein from cottonseed, soybeans, rapeseed, safflower, linseed, corn germ, sunflower, peanuts, palm kernels, sesame, babassu, and copra.

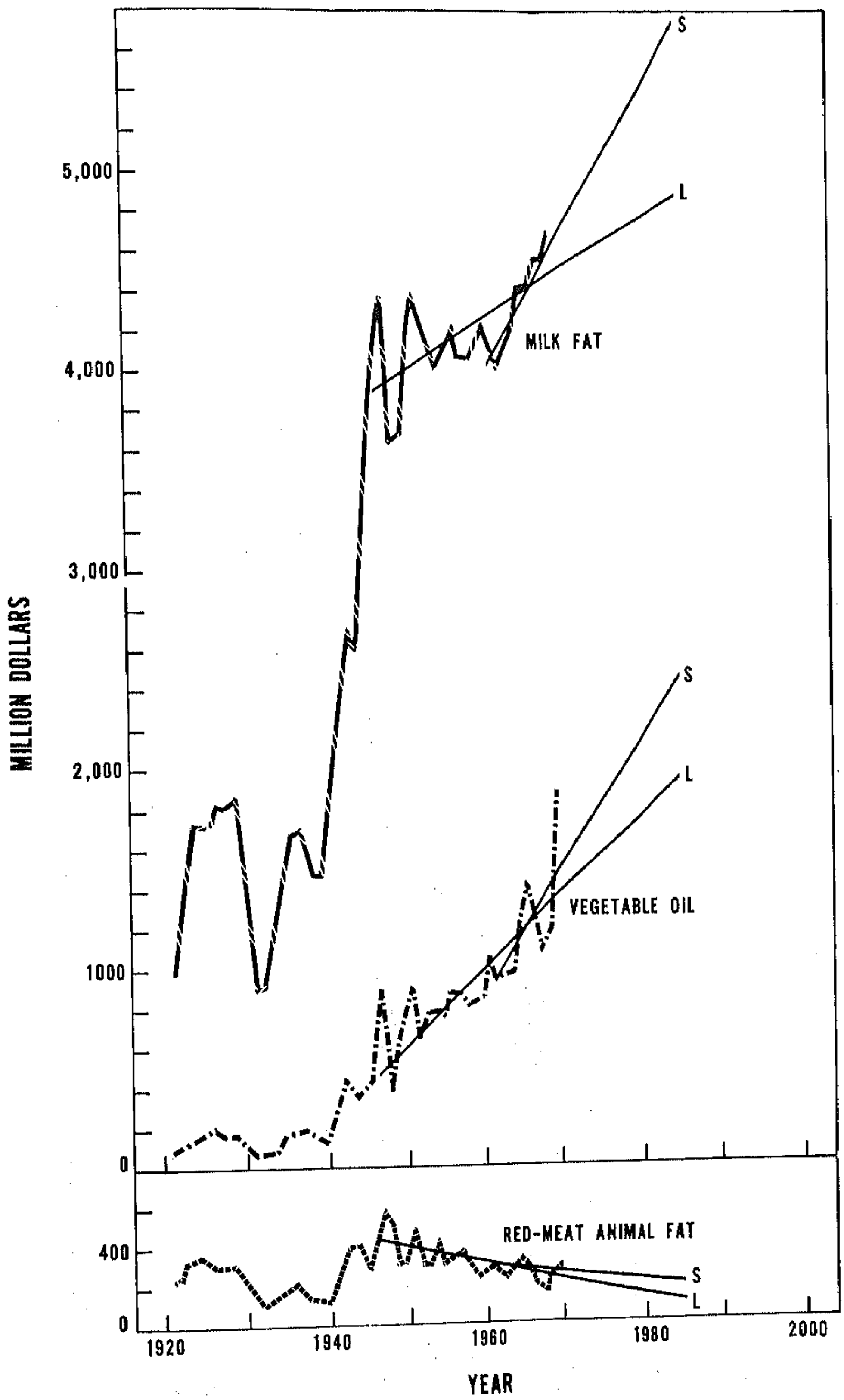

Figure 29.—Value of U.S. vegetable oil, red-meat animal fat, and milk fat, by type.

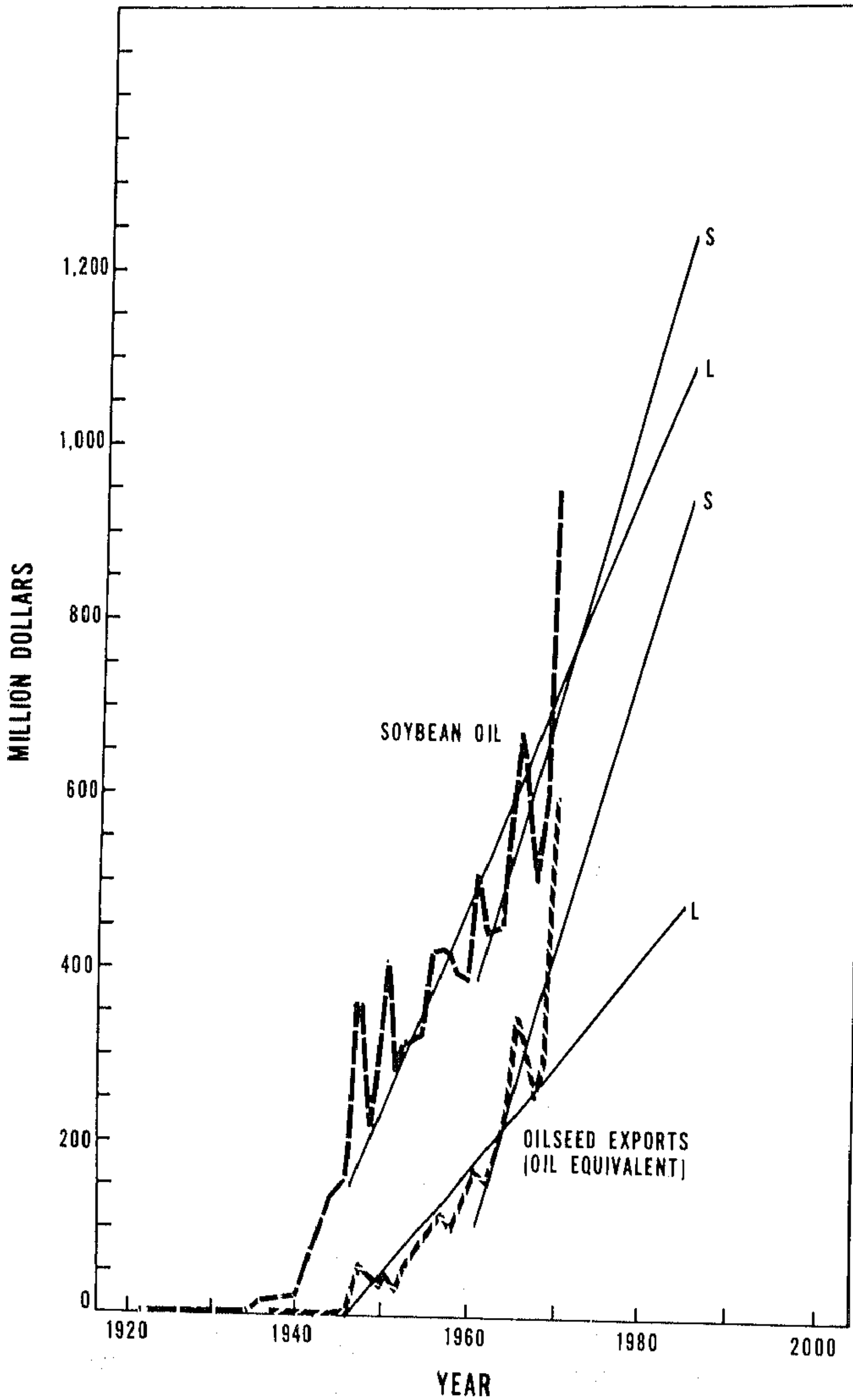

Figure 30.–Value of U.S. soybean oil and edible oilseed exports (oil equivalent).

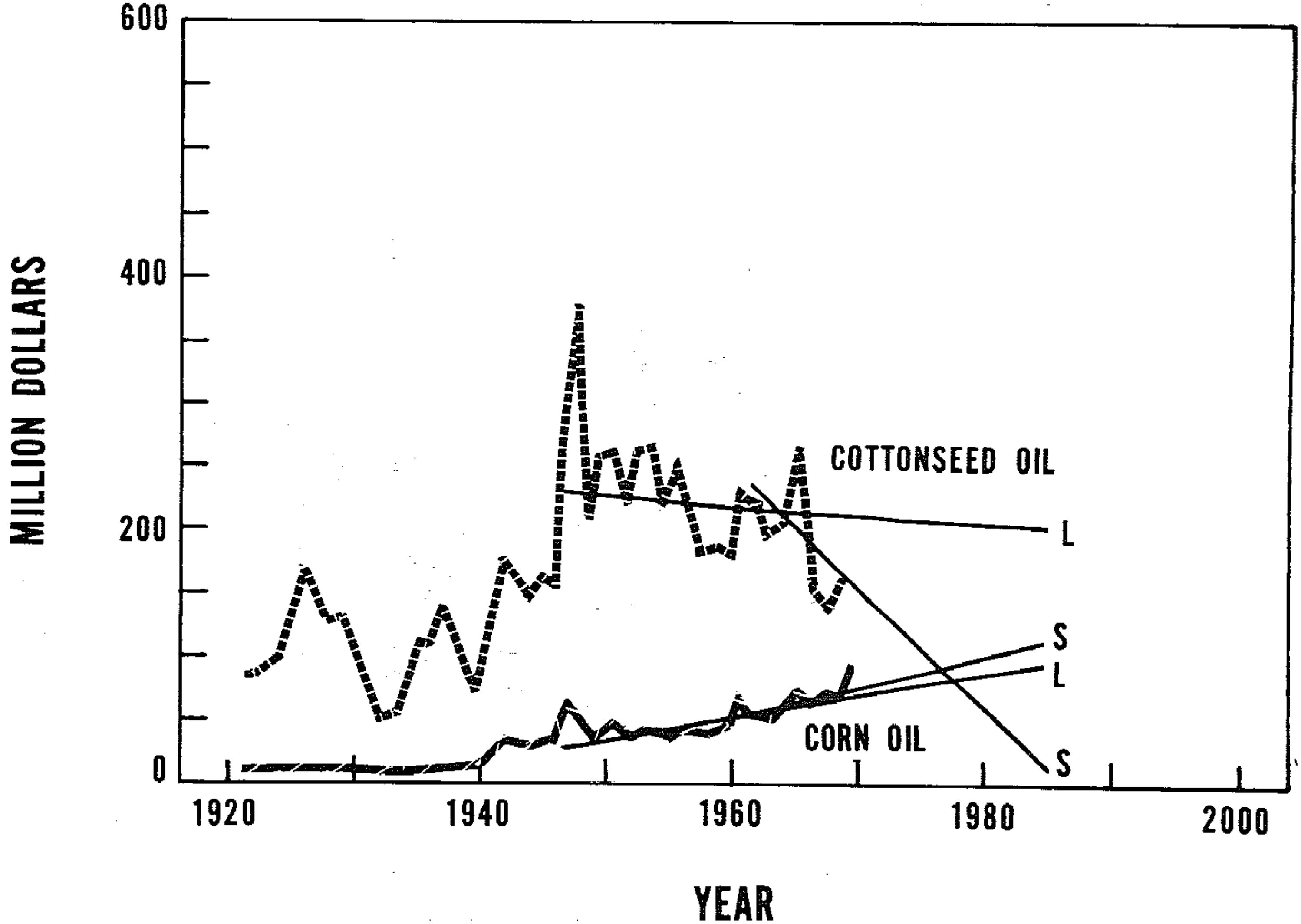

Figure 31.—Value of U.S. cottonseed and corn oils.

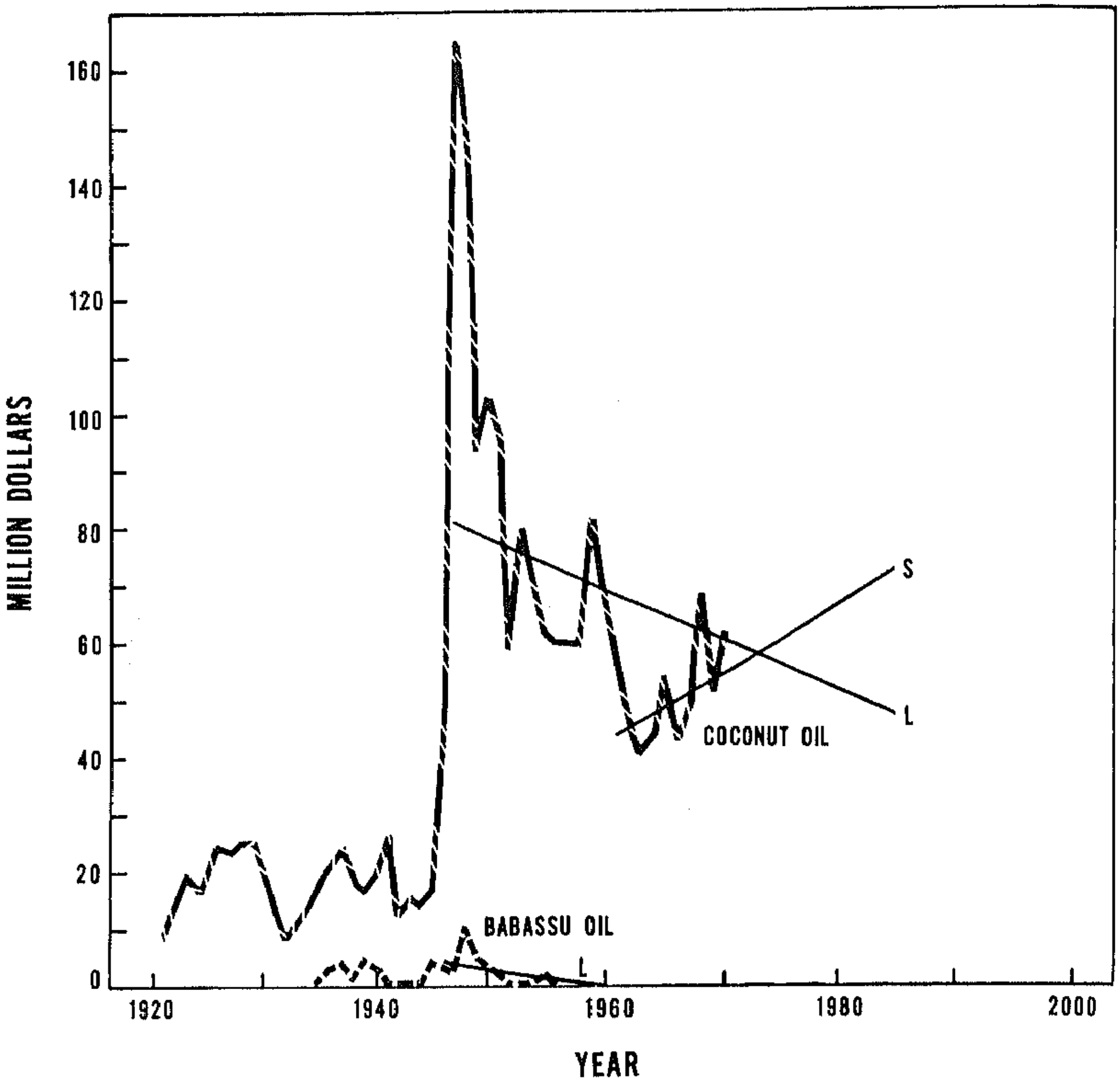

Figure 32.—Value of U.S. coconut and babassu oils.

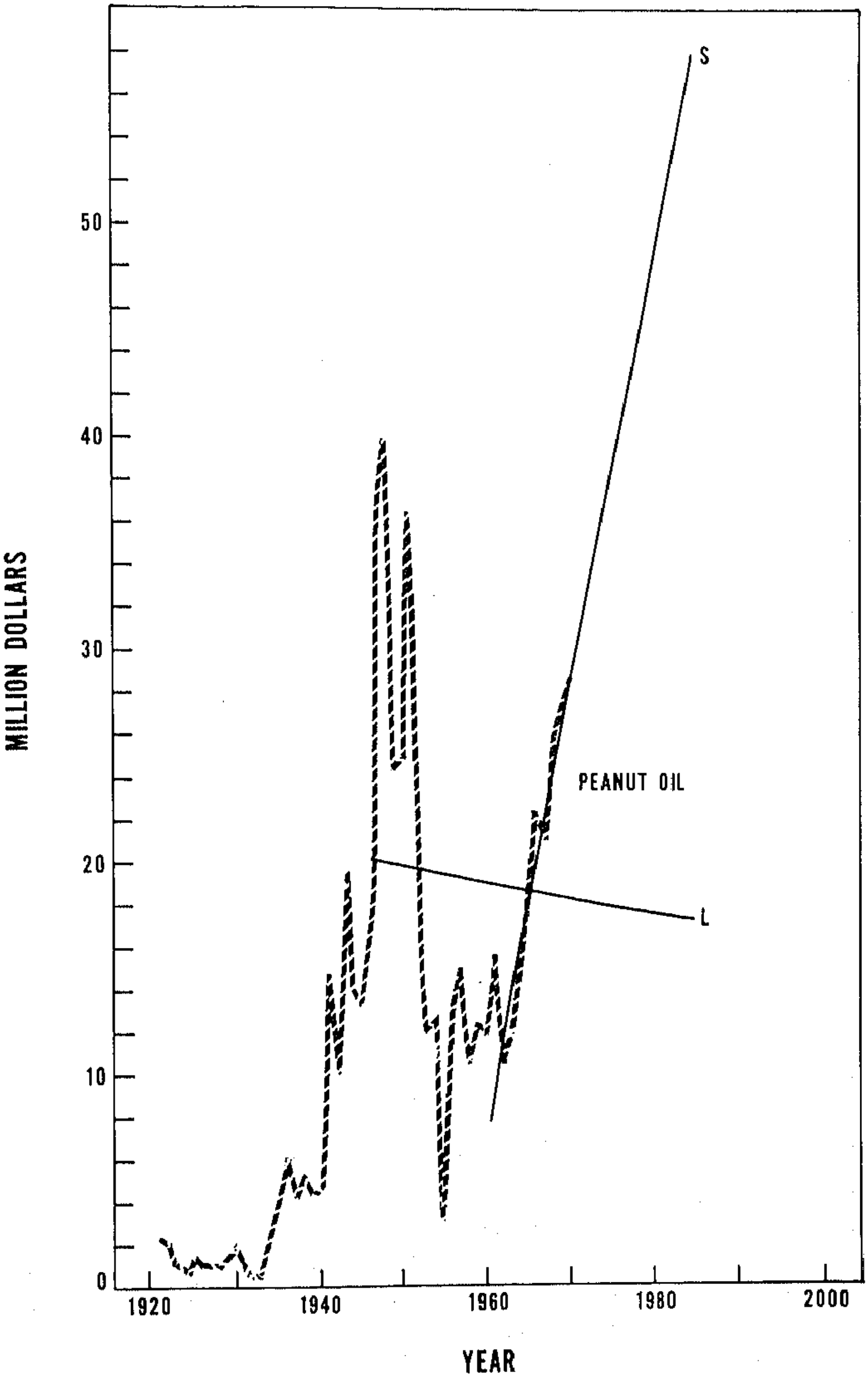

Figure 33.—Value of U.S. peanut oil.

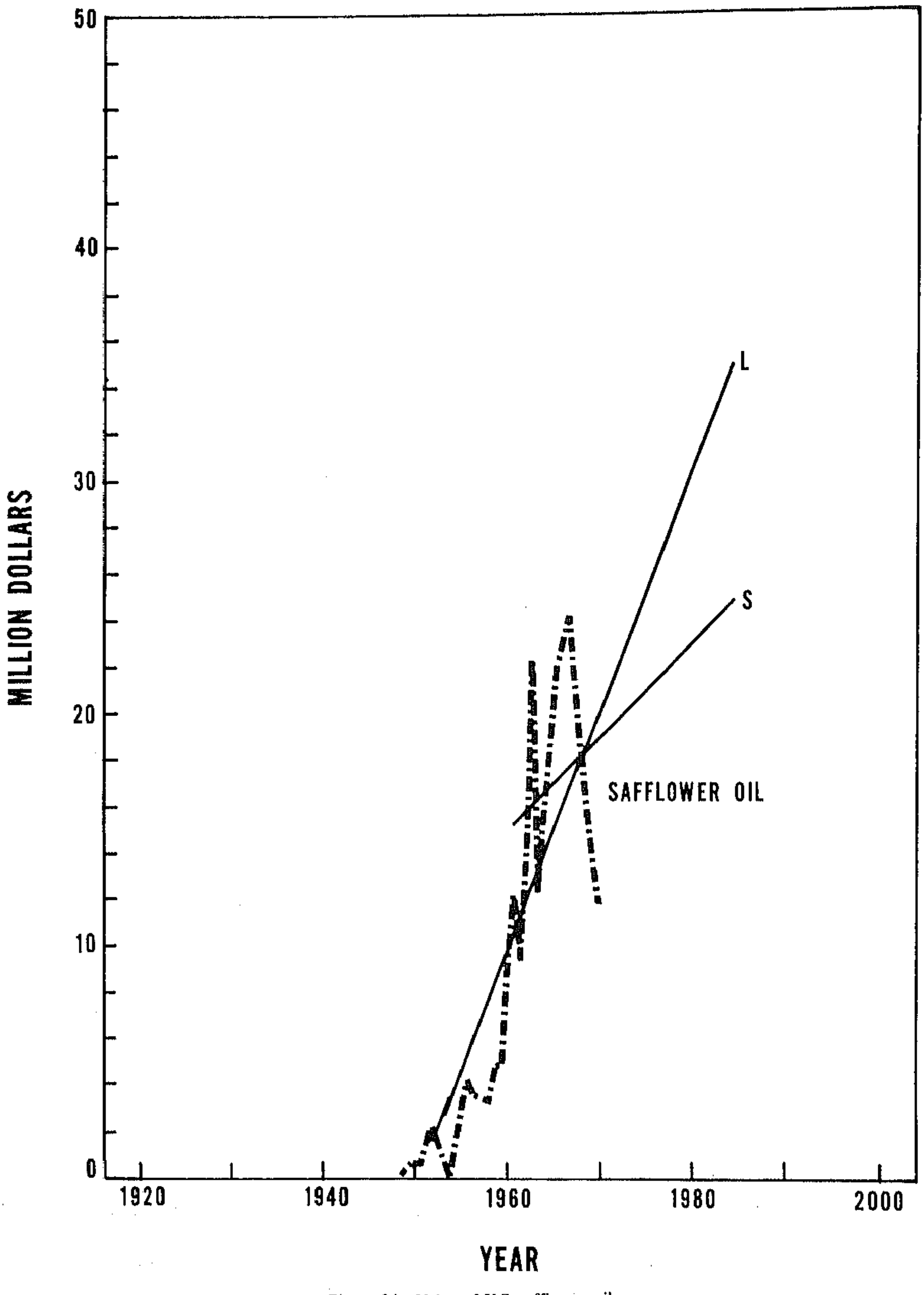

Figure 34.—Value of U.S. safflower oil.

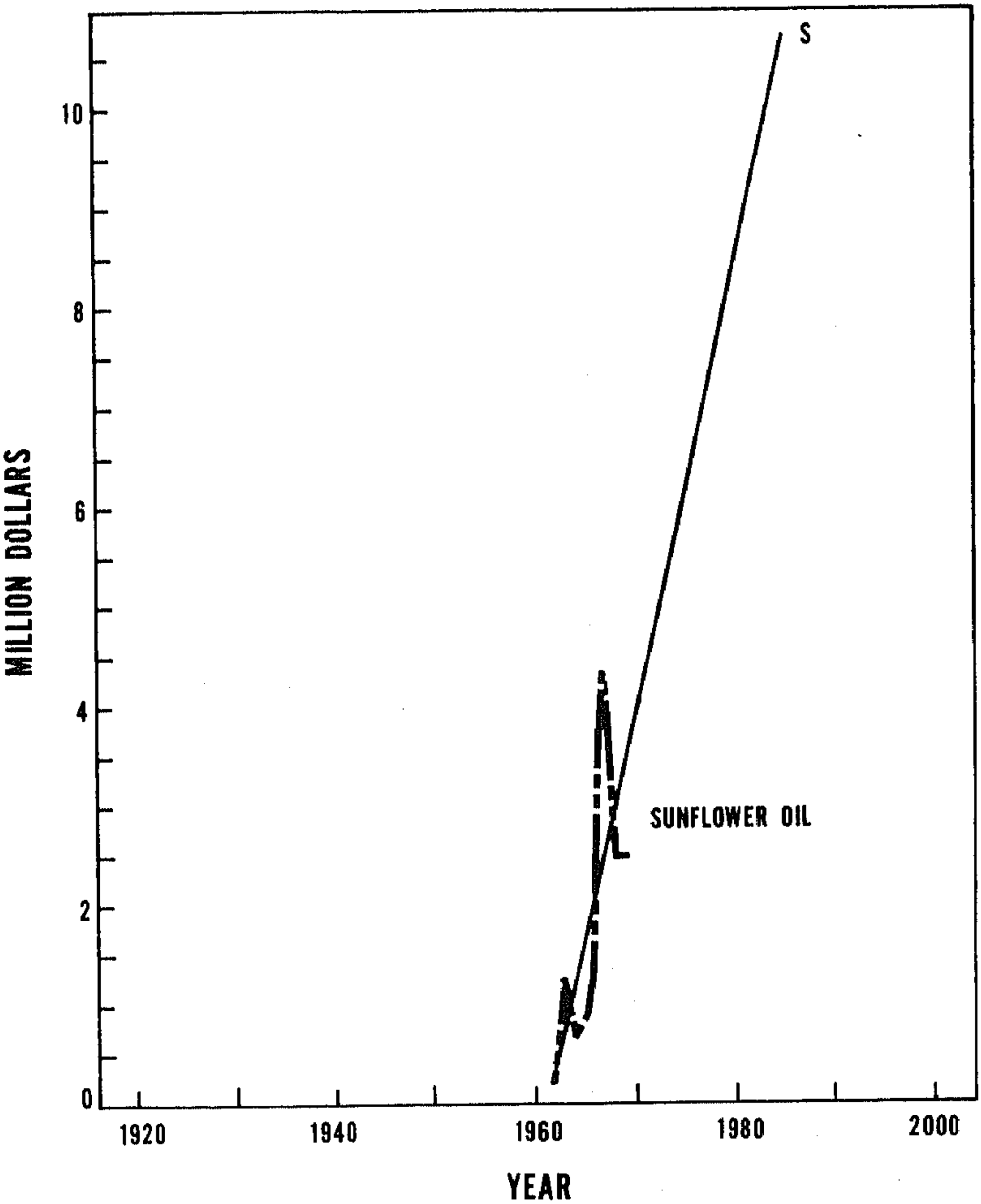

Figure 35.—Value of U.S. sunflower oil.

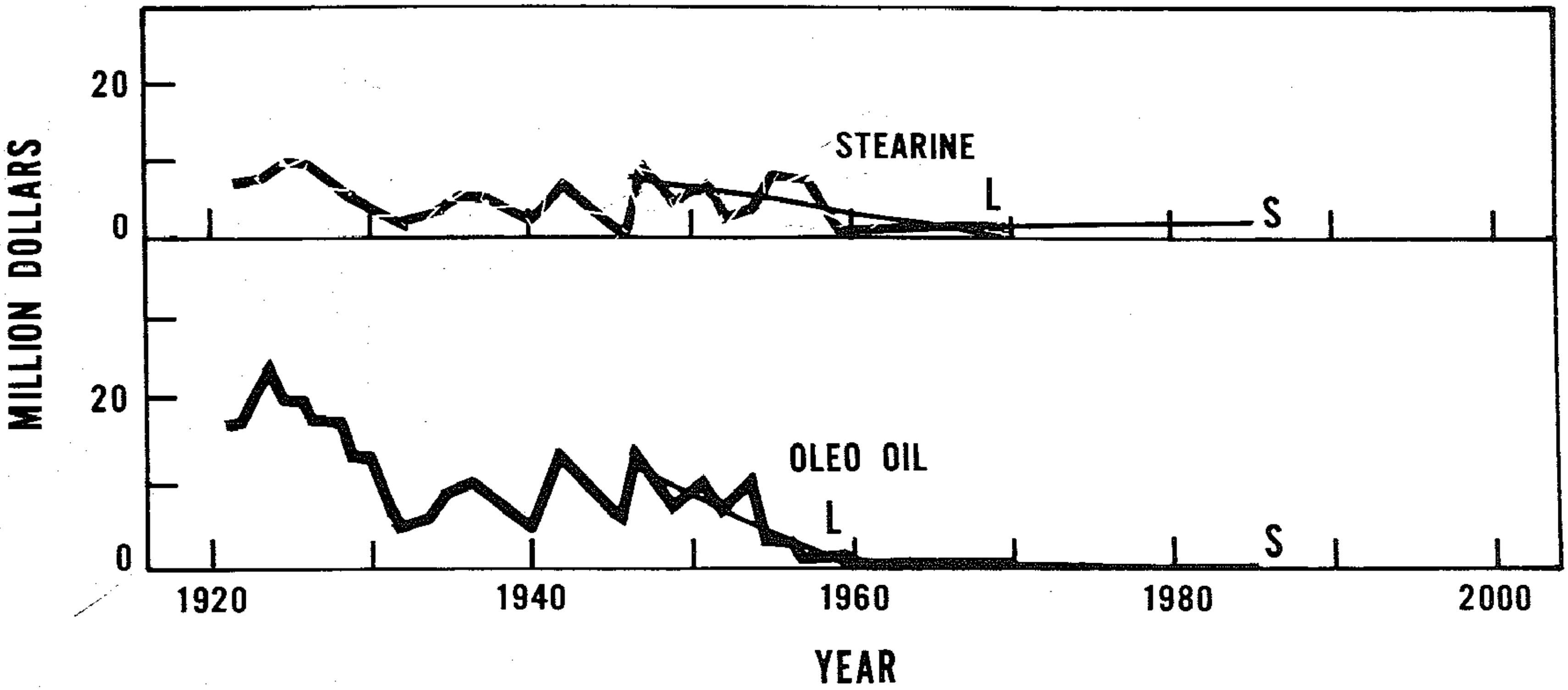

Figure 36.—Value of U.S. stearine and oleo oil.

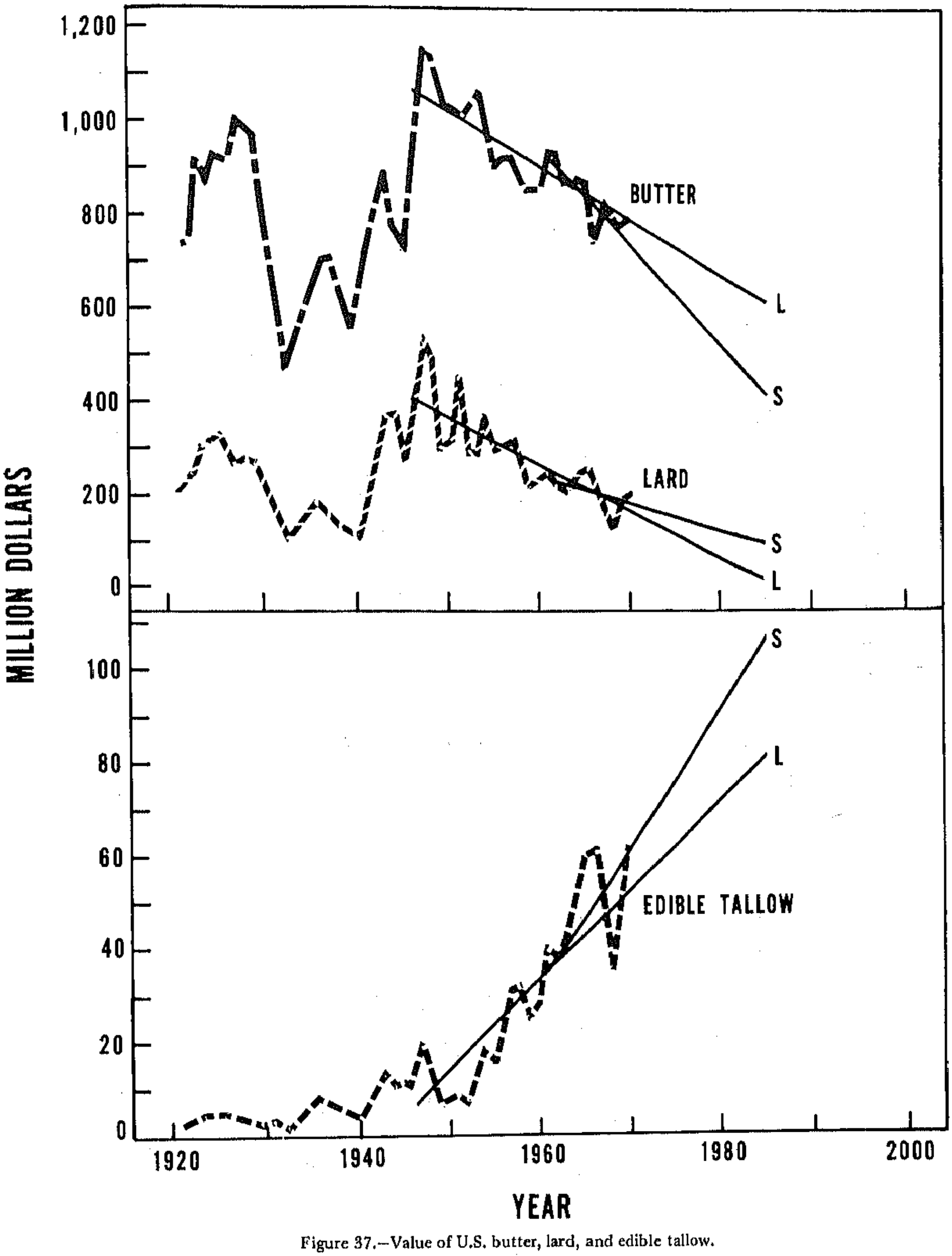

Figure 37.—Value of U.S. butter, lard, and edible tallow.

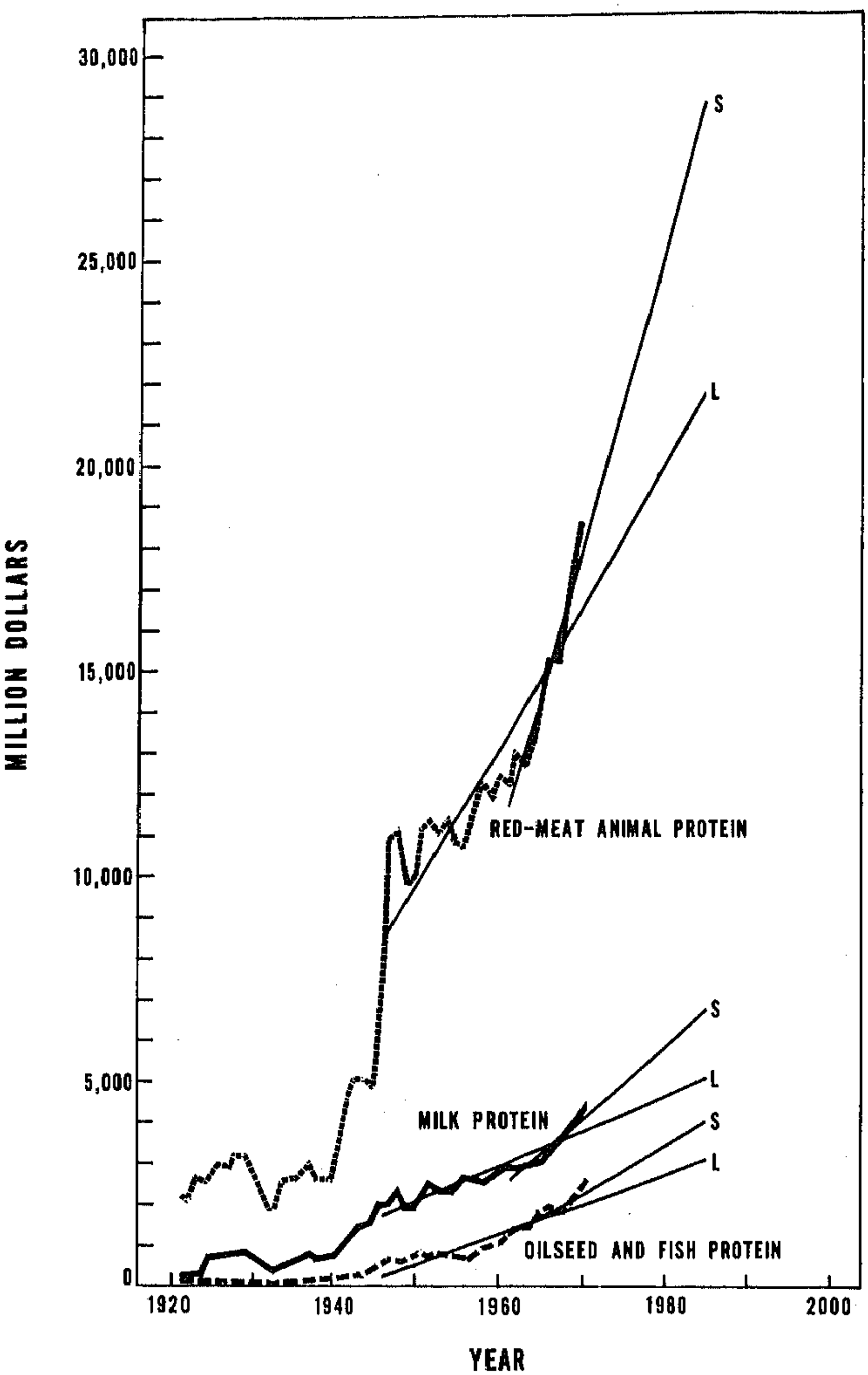

Figure 38.—Value of U.S. oilseed, fishmeal, red-meat, and milk proteins.

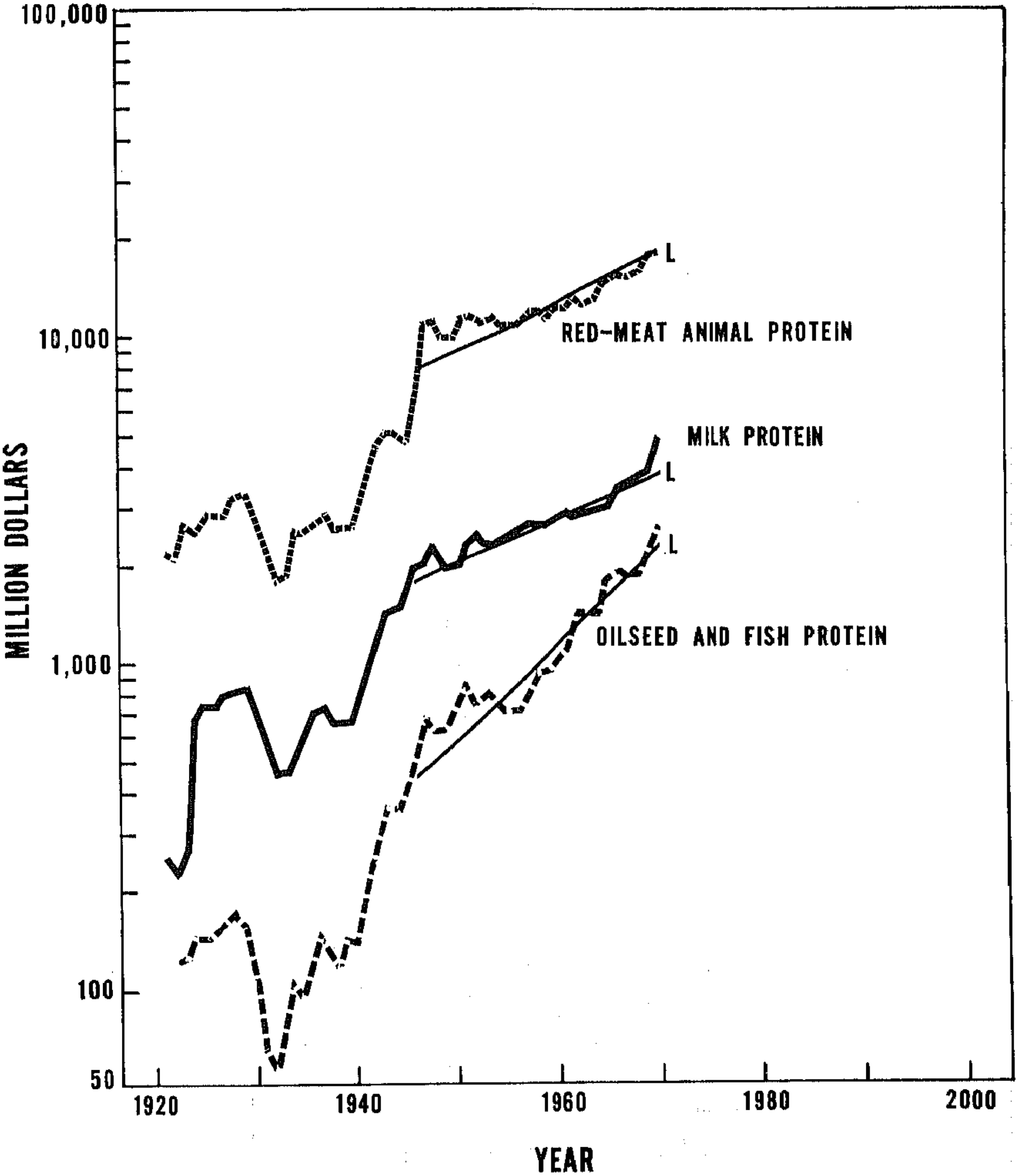

Figure 39.—Value of U.S. oilseed, fishmeal, red-meat, and milk proteins (semilog plot for comparing rates of growth).

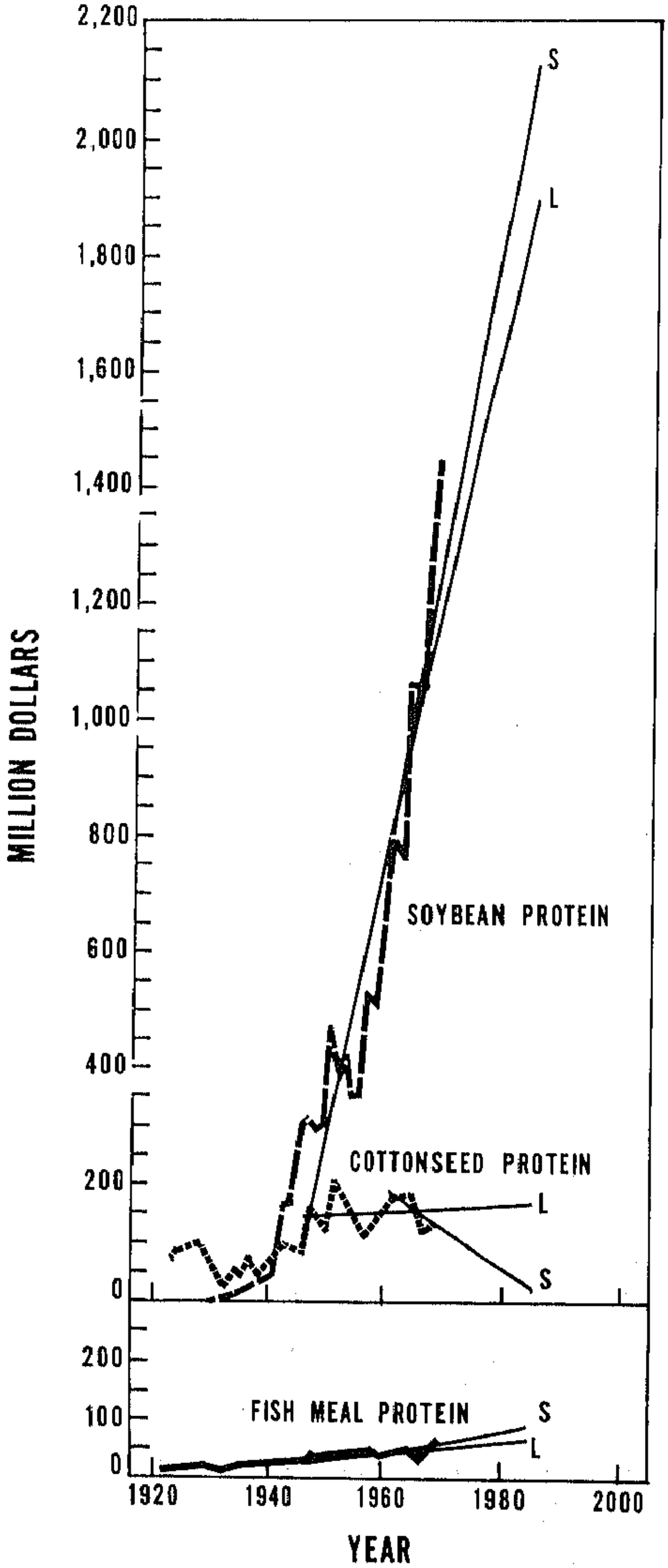

Figure 40.—Value of U.S. soybean, cottonseed, and fishmeal proteins.

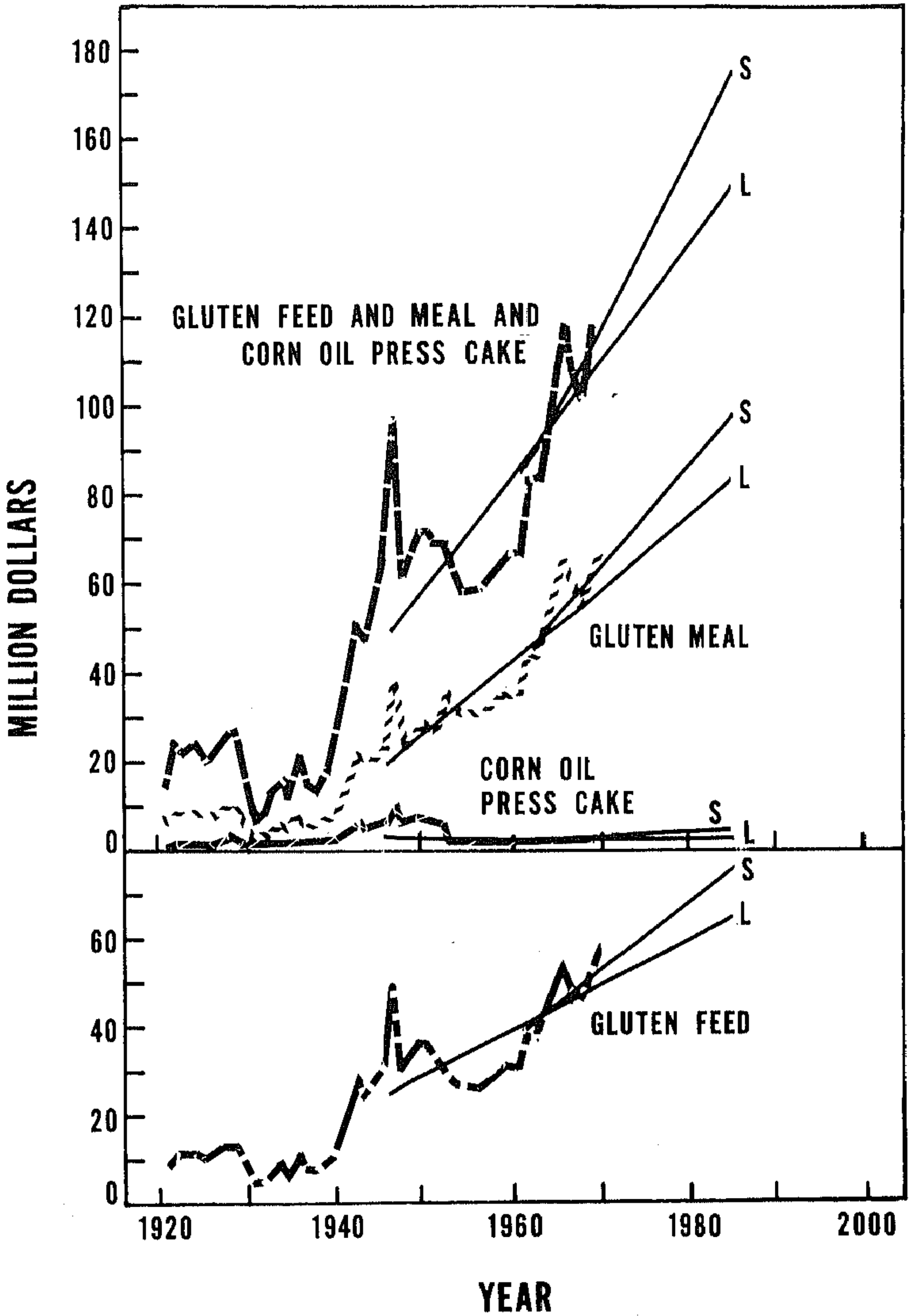

Figure 41.—Value of U.S. gluten feed, gluten meal, and corn oil press cake proteins.

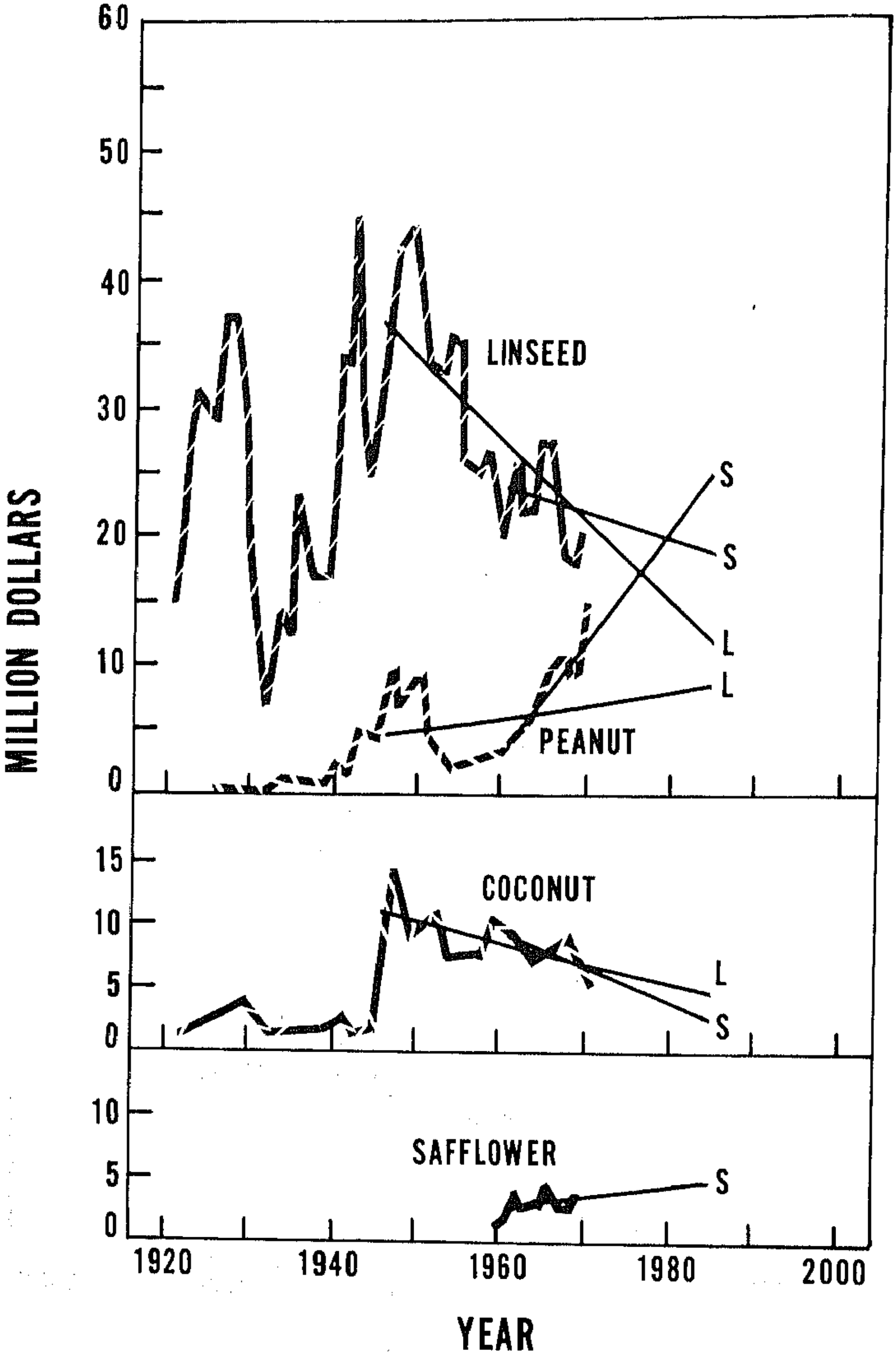

Figure 42.—Value of U.S. linseed, peanut, coconut, and safflower proteins.

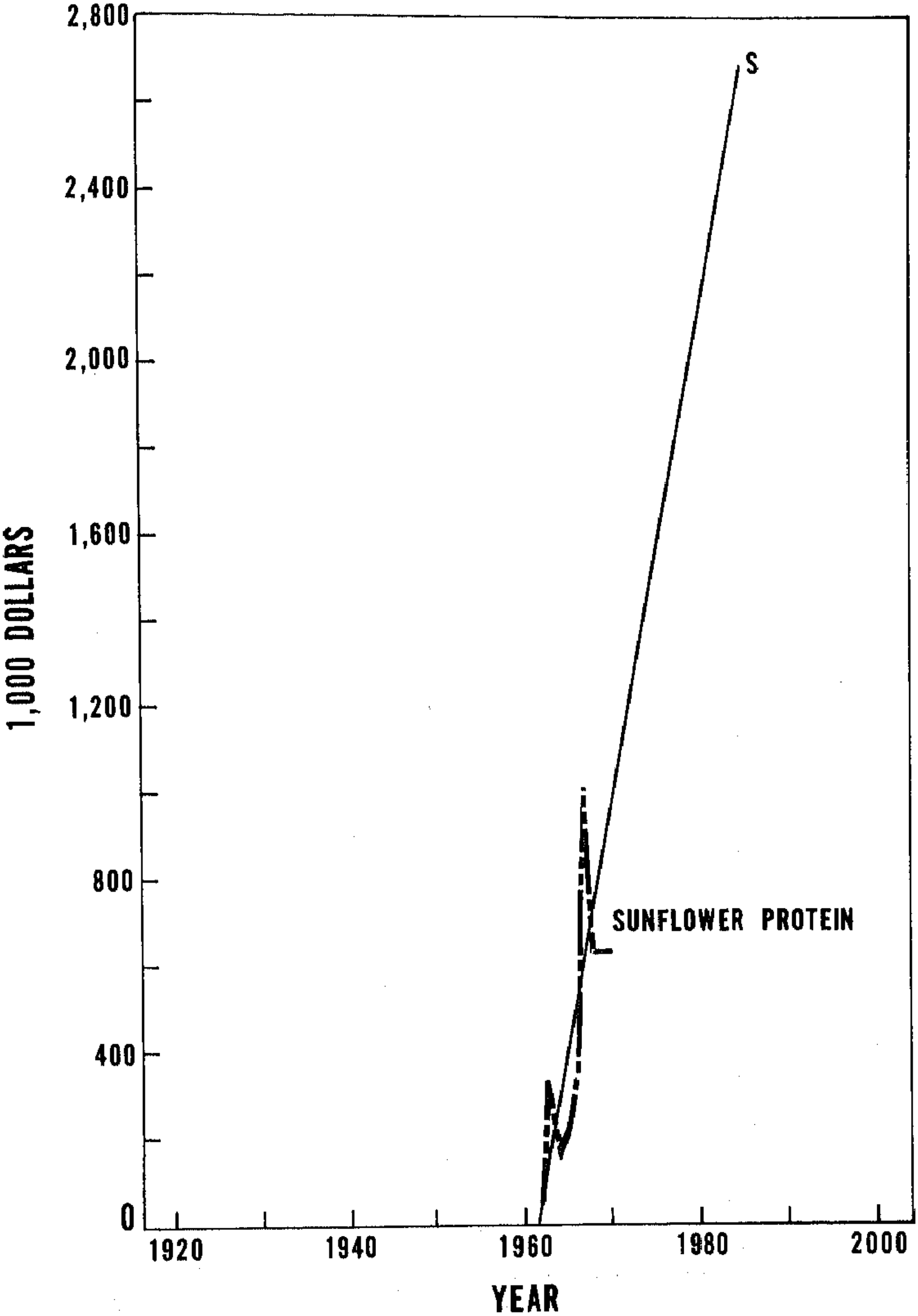

Figure 43.—Value of U.S. sunflower protein.

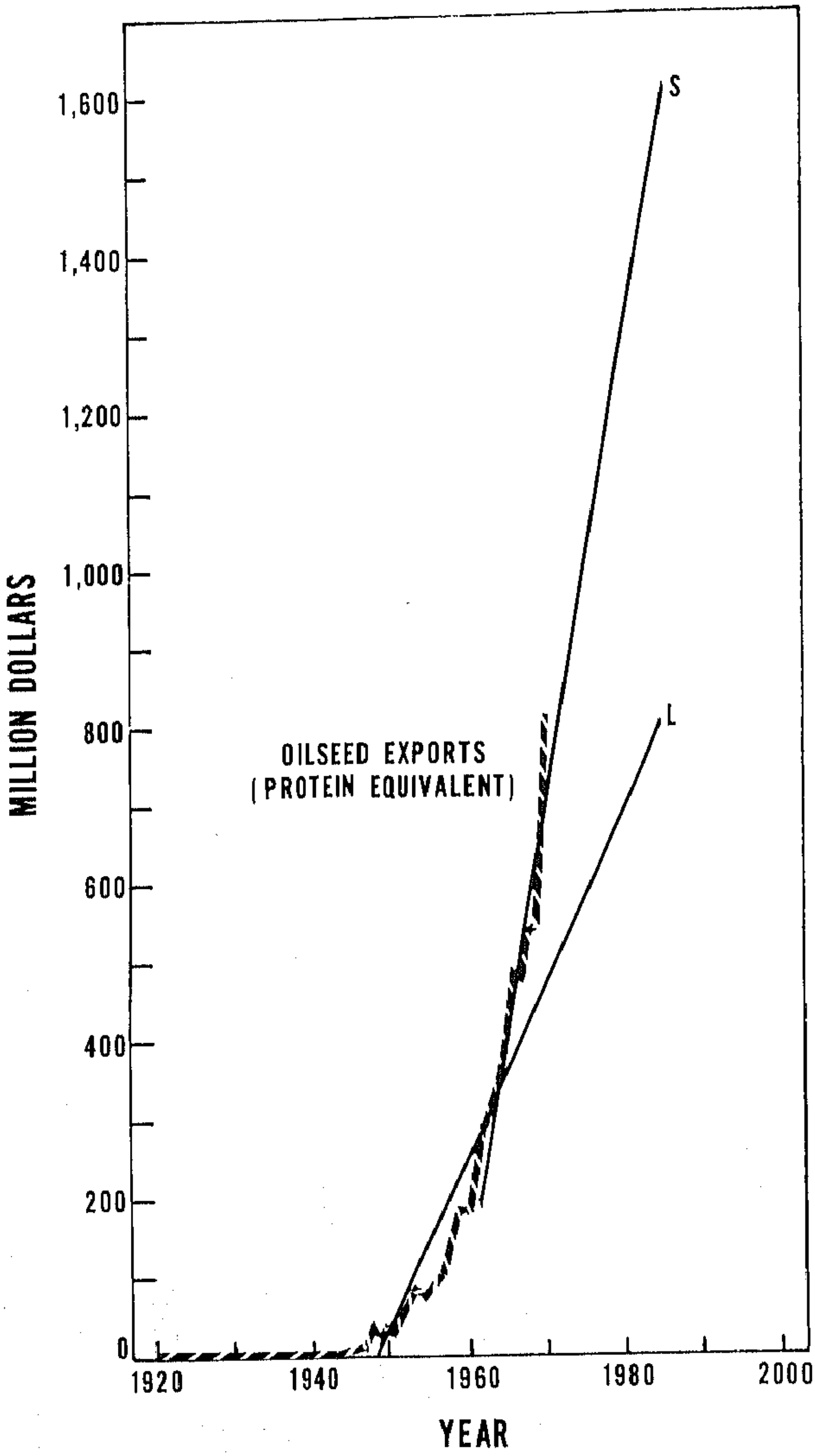

Figure 44.—Value of U.S. oilseed exports (protein equivalent).

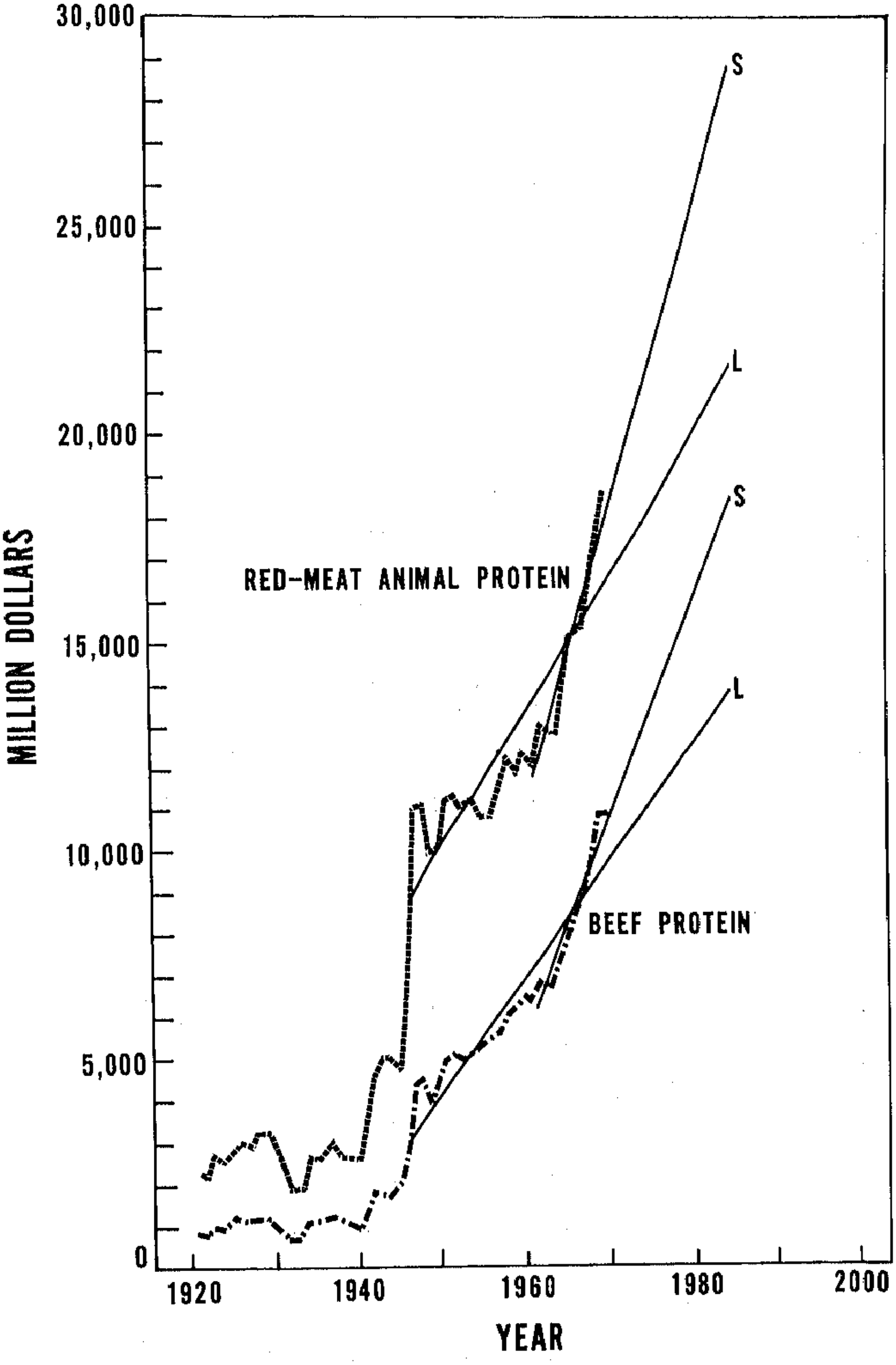

Figure 45.—Value of U.S. red-meat animal and beef proteins.

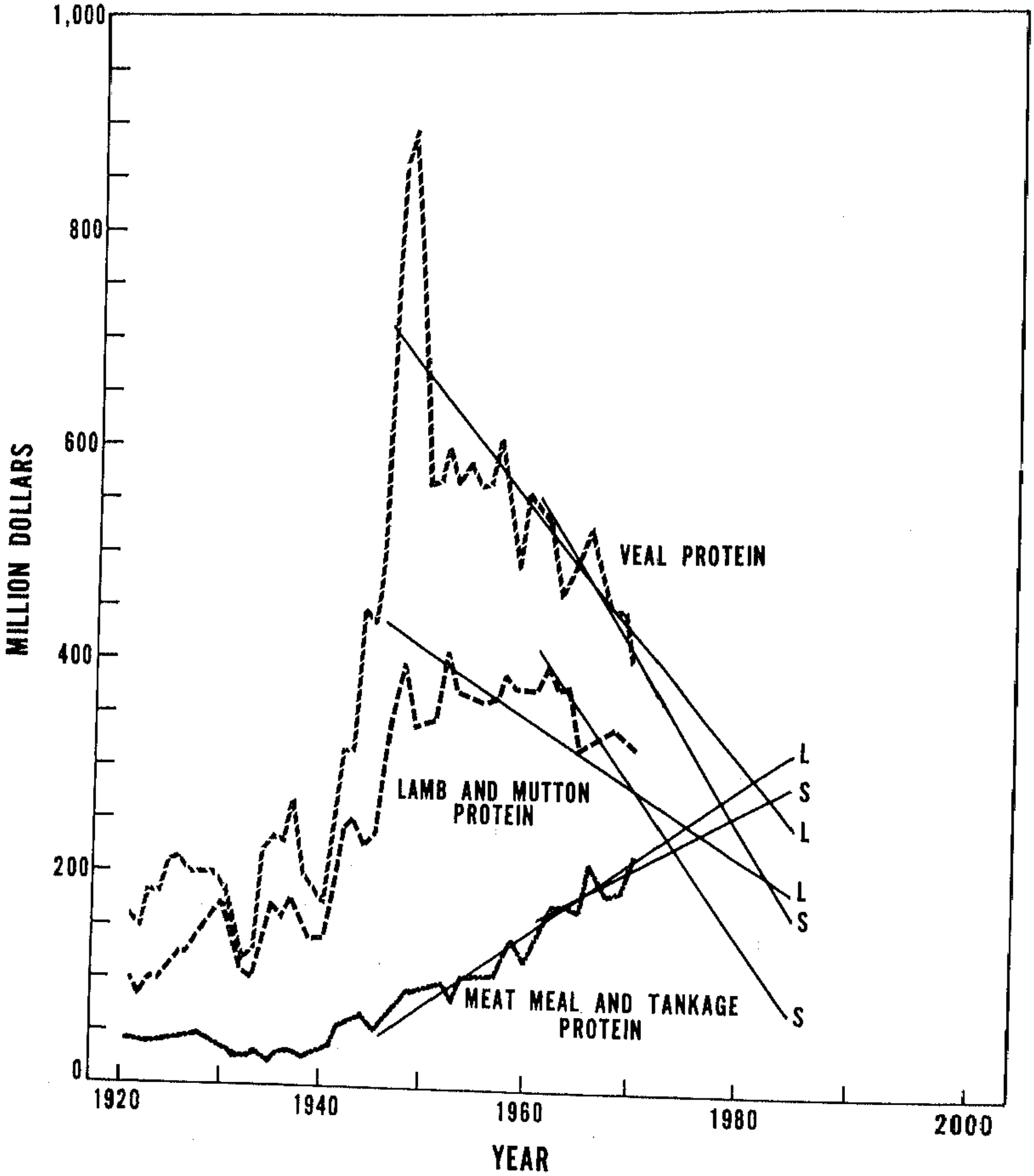

Figure 46.–Value of U.S. veal, lamb, mutton, meat-meal, and tankage proteins.

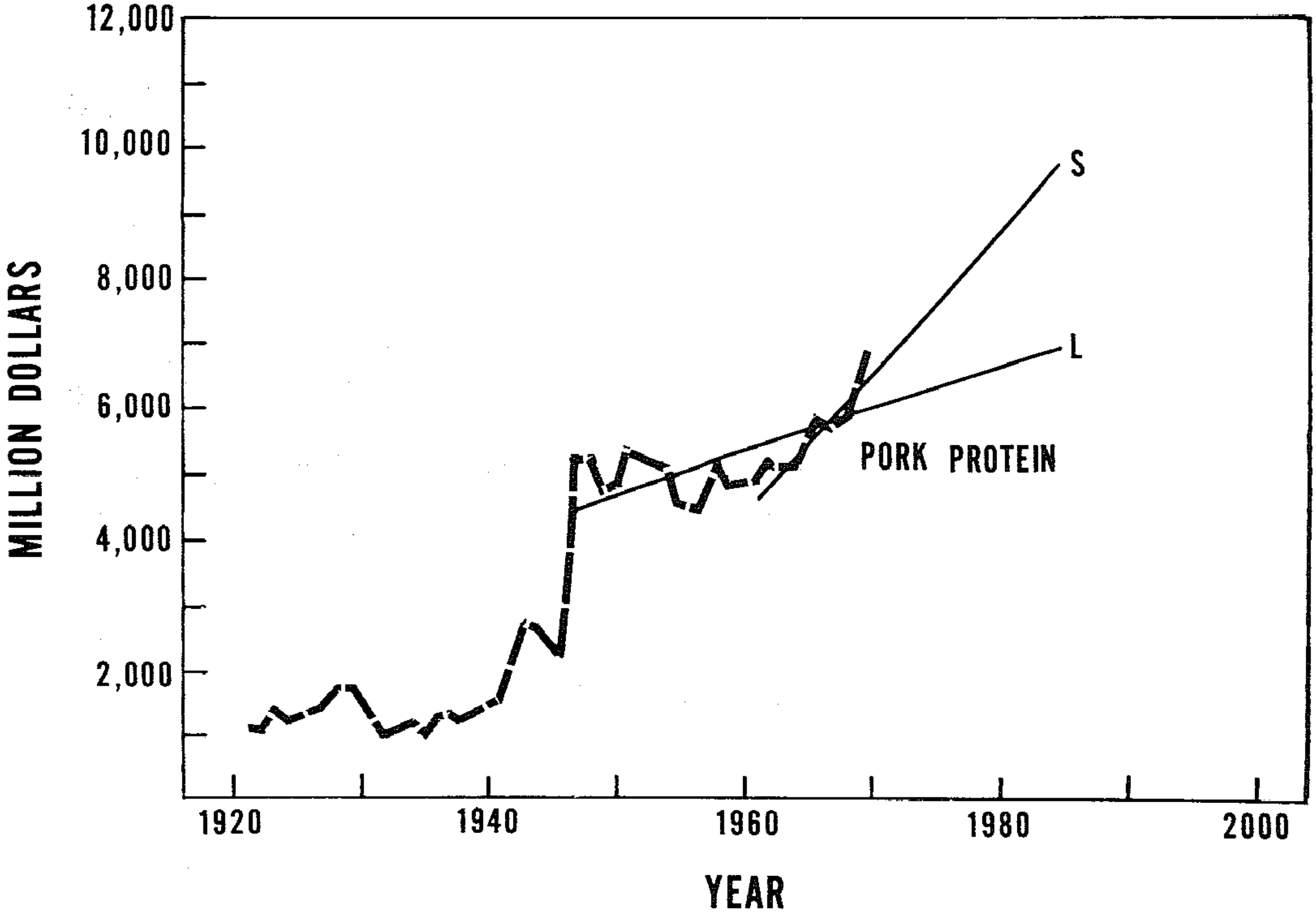

Figure 47.—Value of U.S. pork protein.

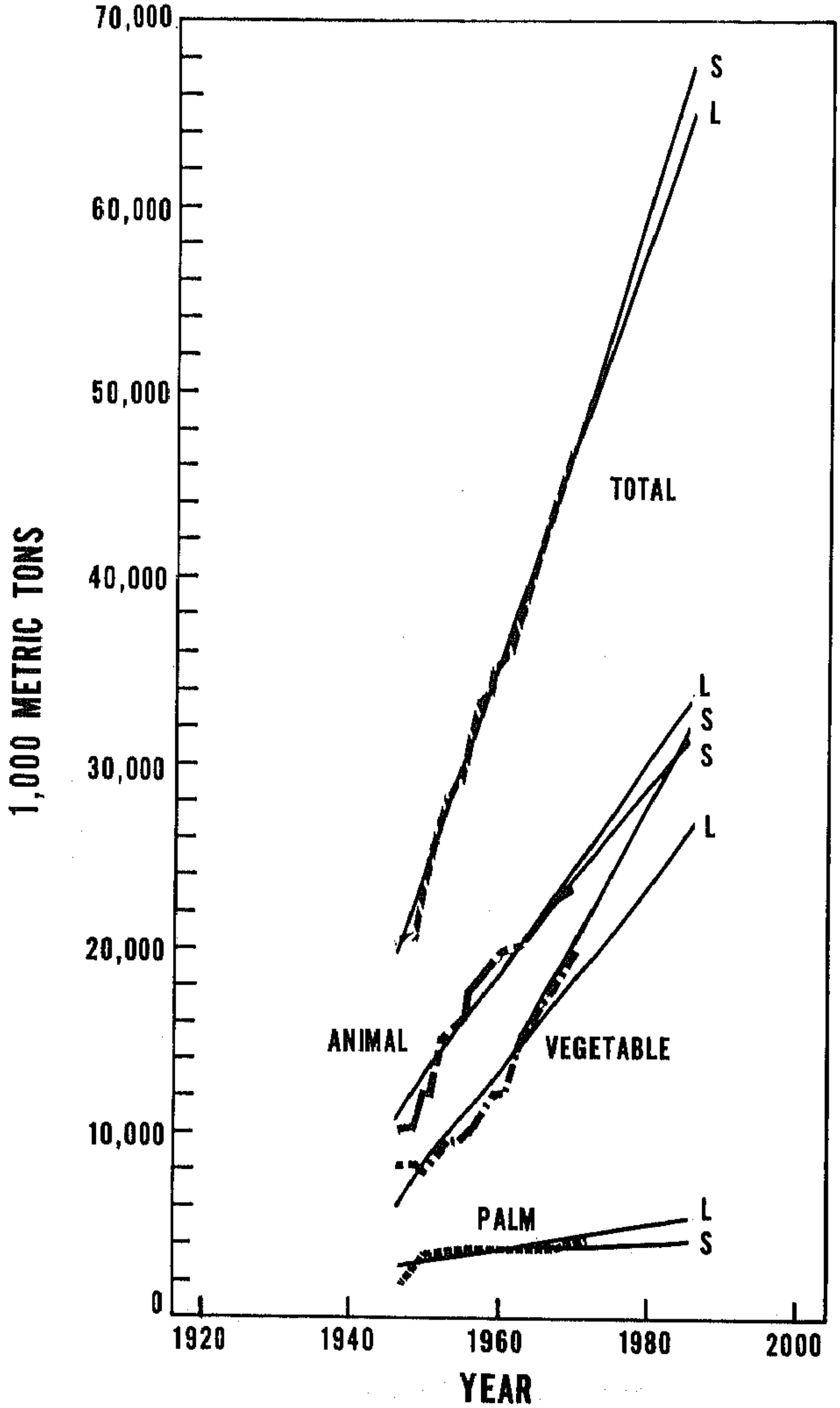

Figure 48.--World production of edible fats and oils, vegetable and palm oils, and animal fats.

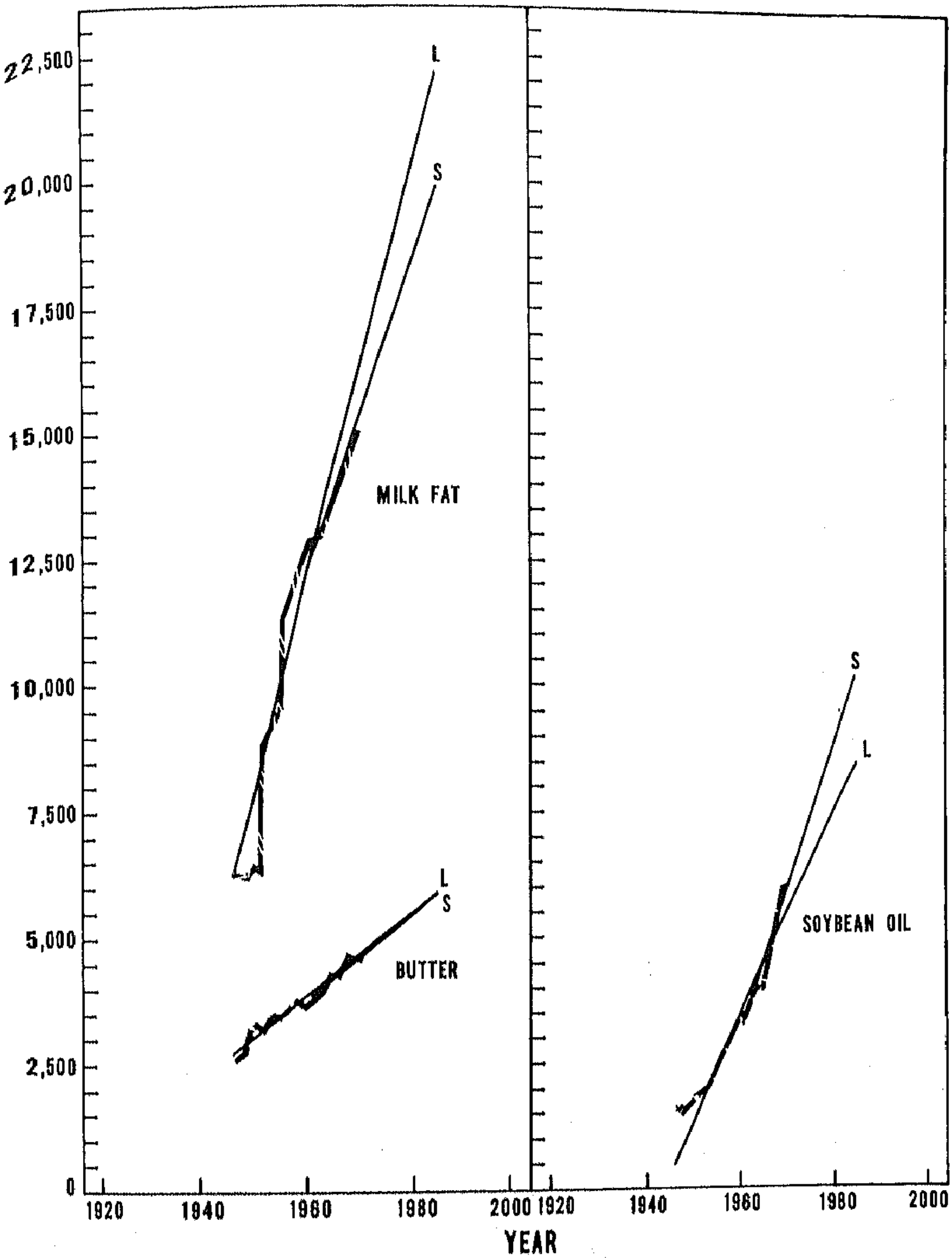

Figure 49.—World production of milk fat, butter, and soybean oil.

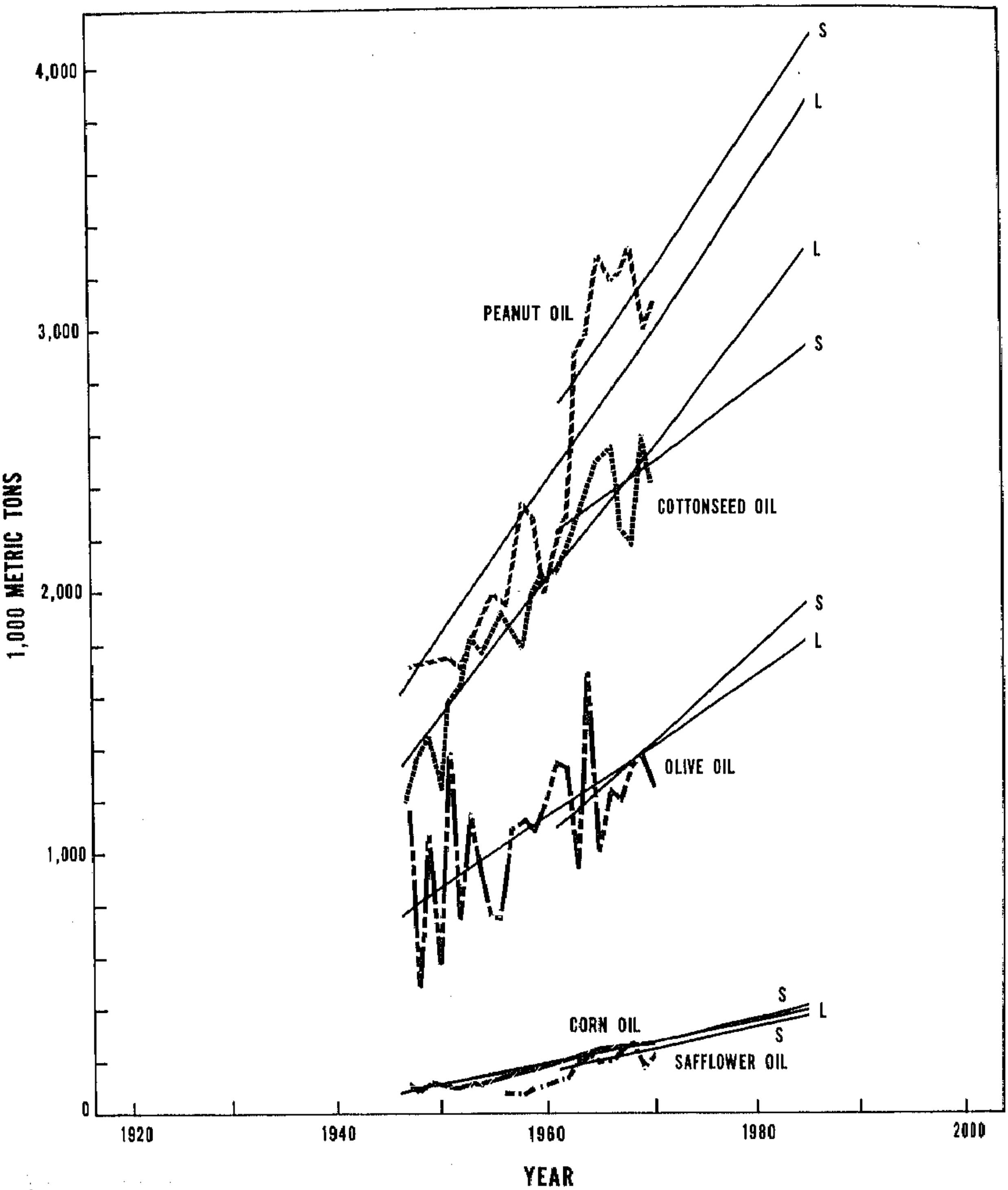

Figure 50.—World production of peanut, cottonseed, olive, corn, and safflower oils.

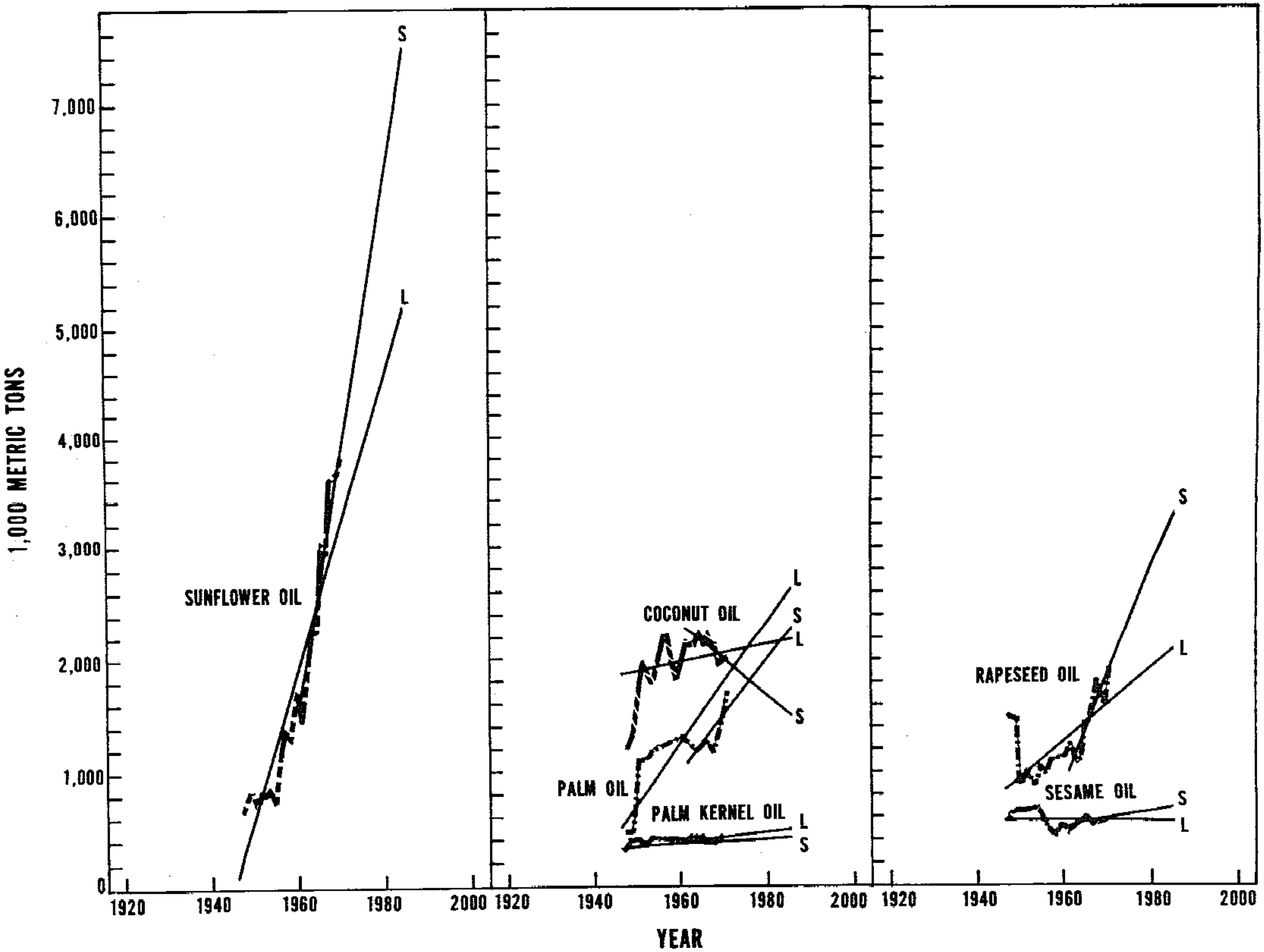

Figure 51.—World production of sunflower, coconut, palm, palm kernel, rapeseed, and sesame oils.

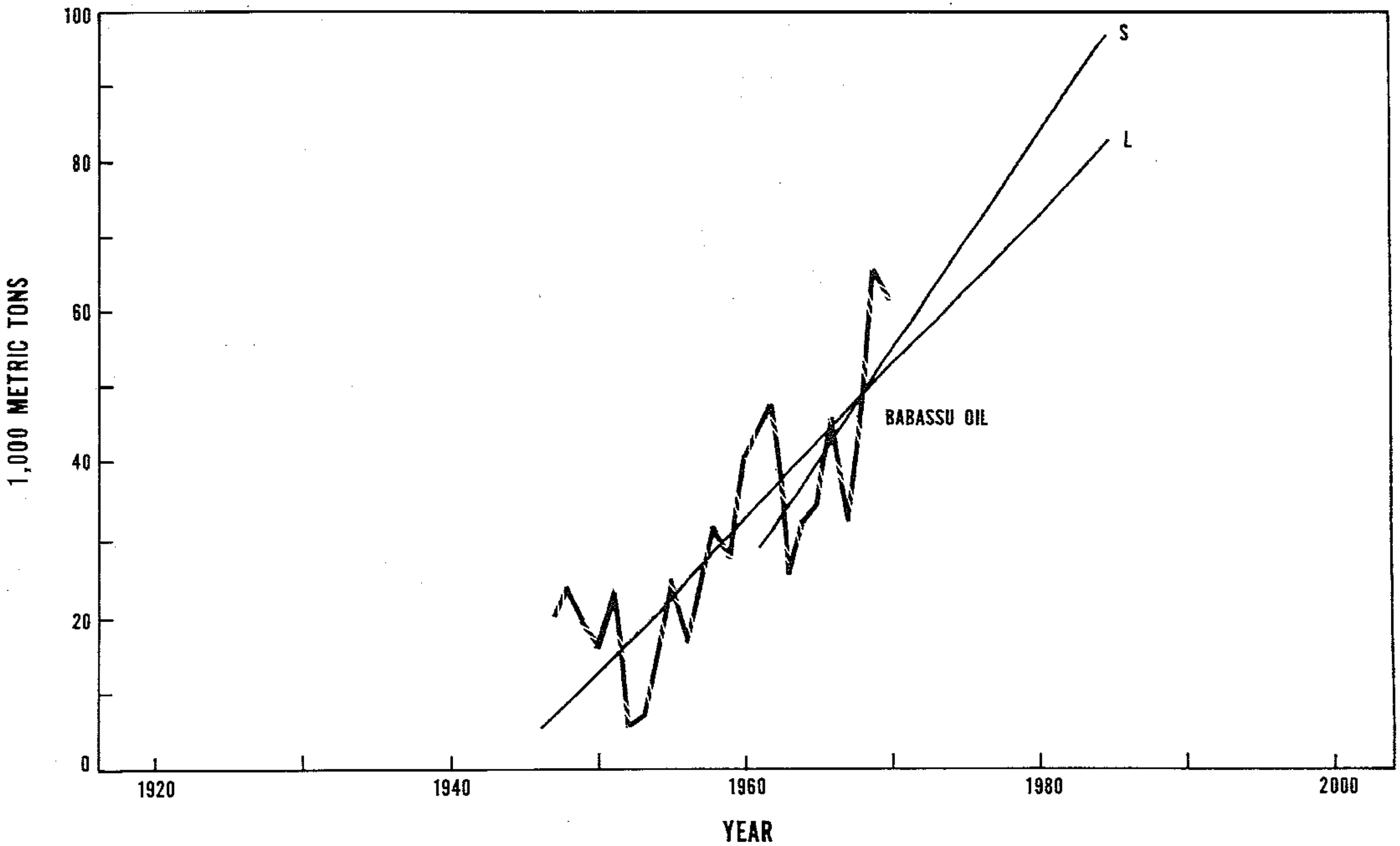

Figure 52.—World production of edible and inedible tallow and grease.

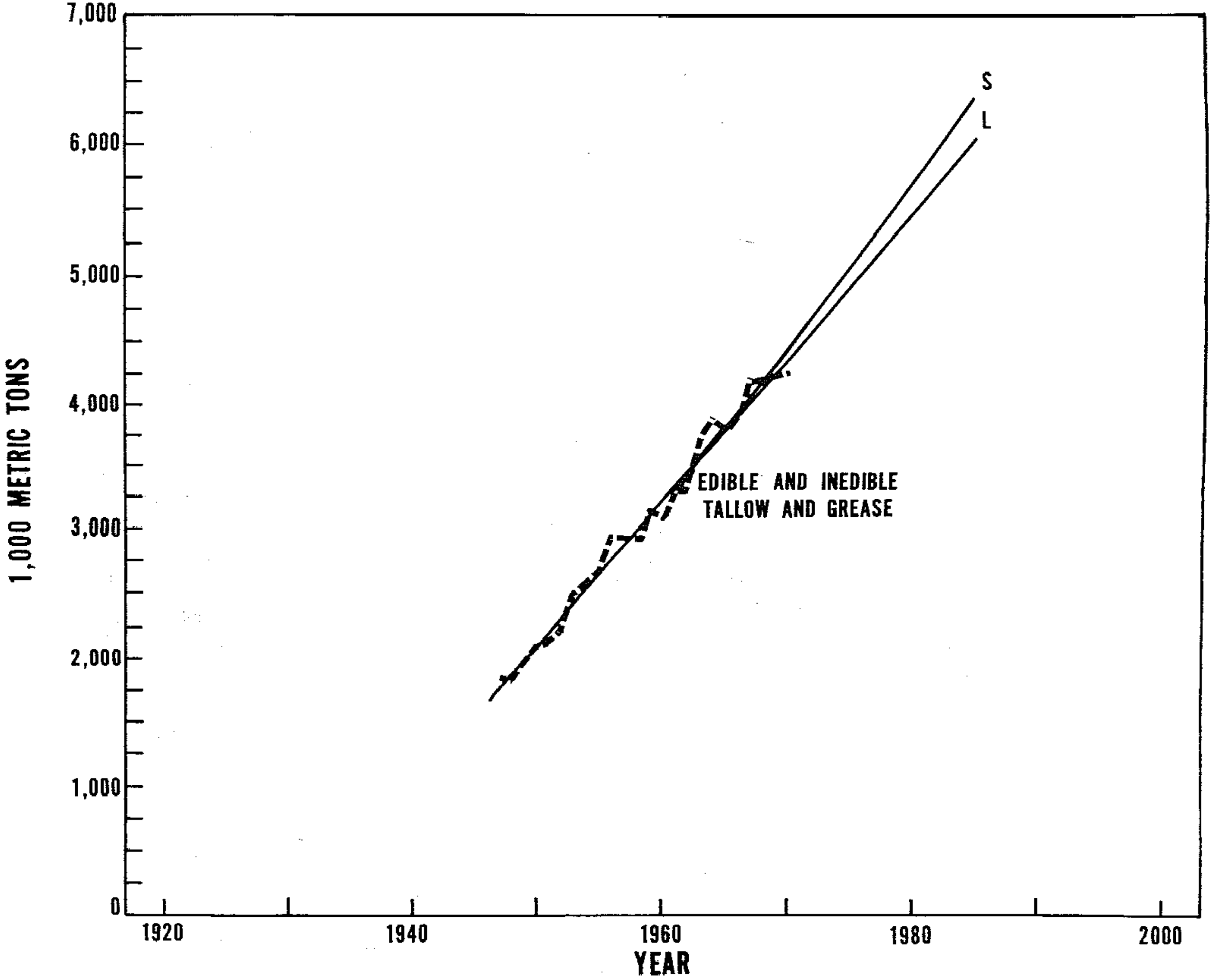

Figure 53.—World production of edible and inedible tallow and grease.

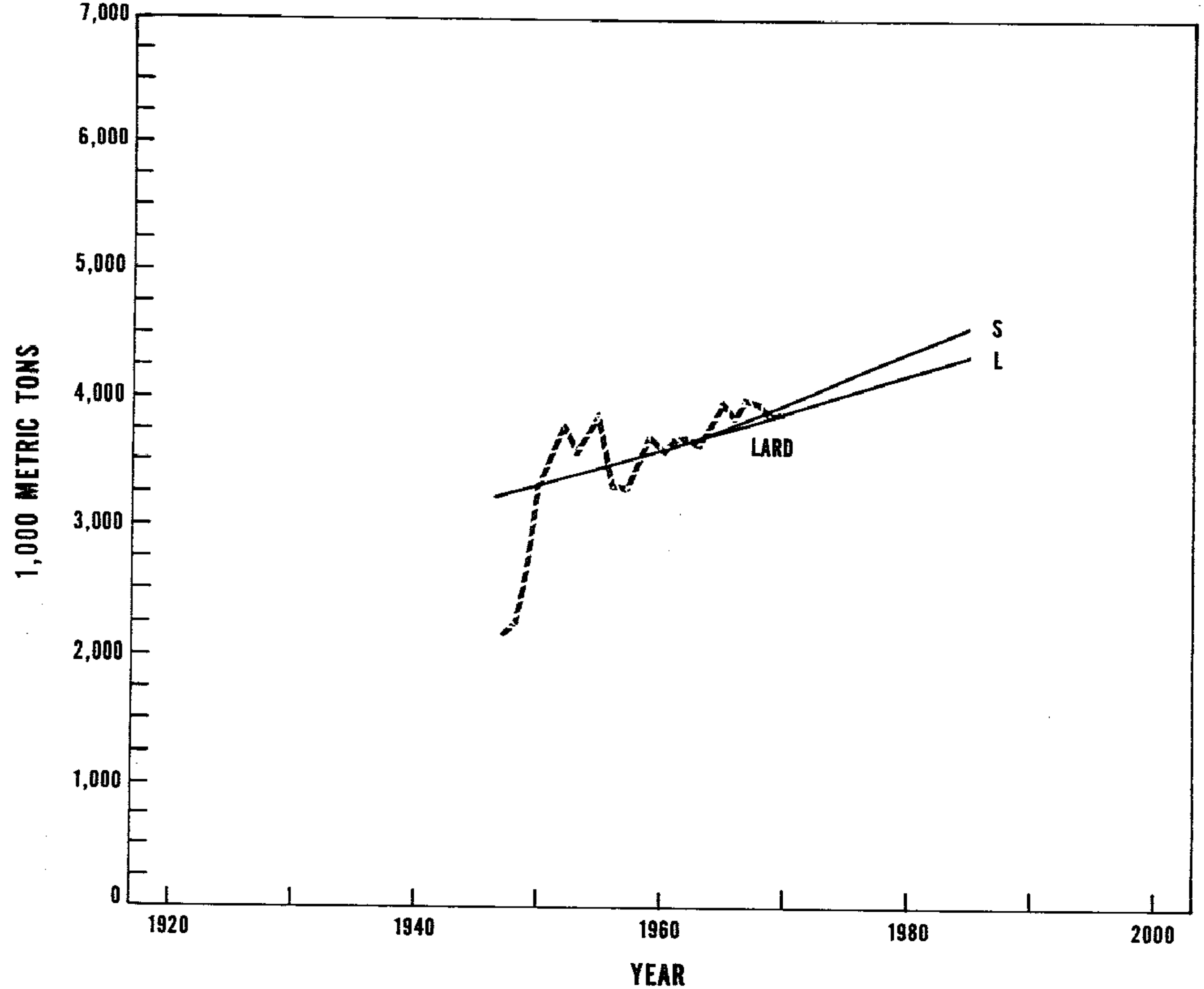

Figure 54.—World production of lard.

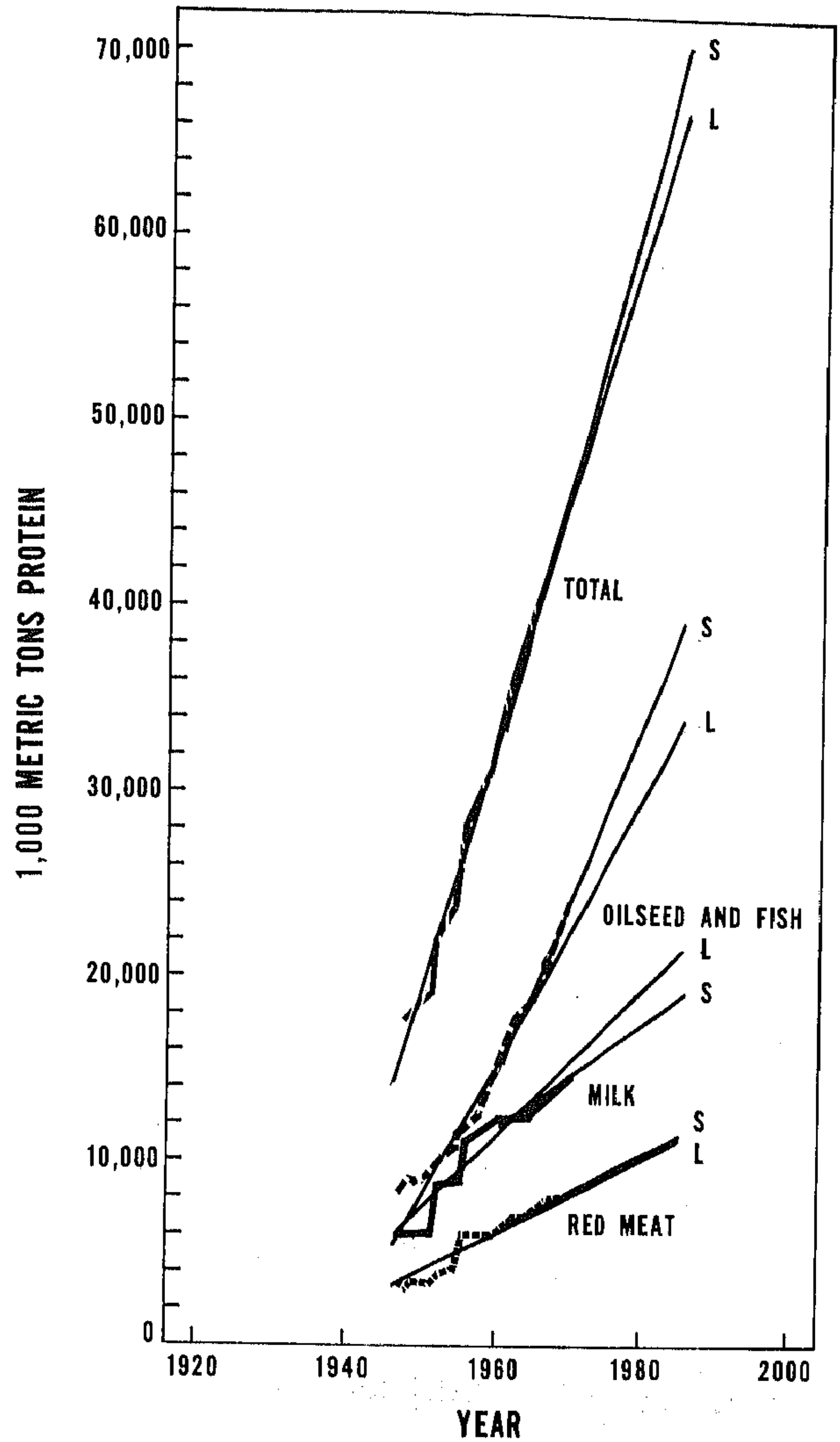

Figure 55.—World production of total oilseed, fishmeal, red-meat, and milk proteins, by type.

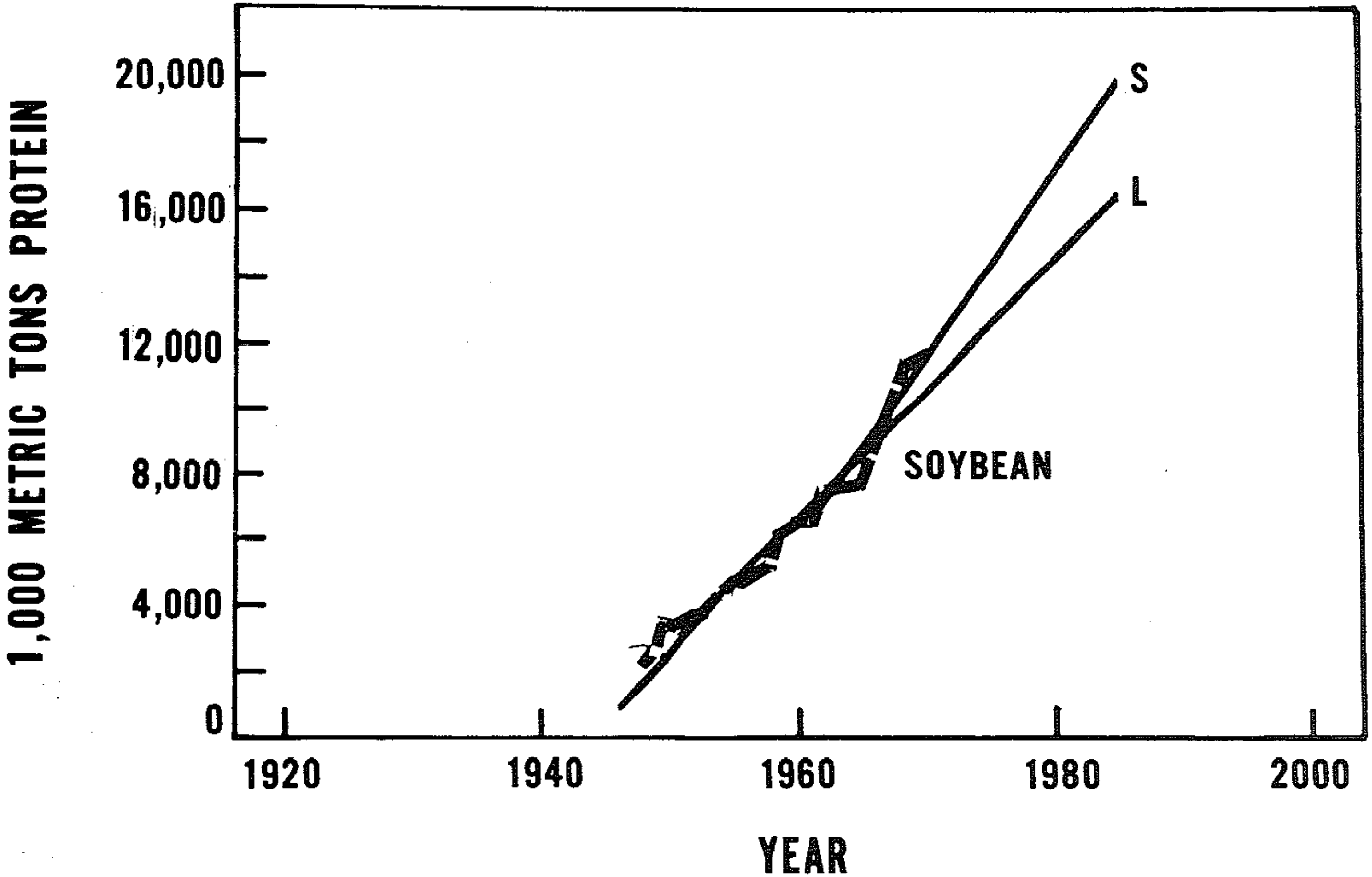

Figure 56.—World production of soybean protein.

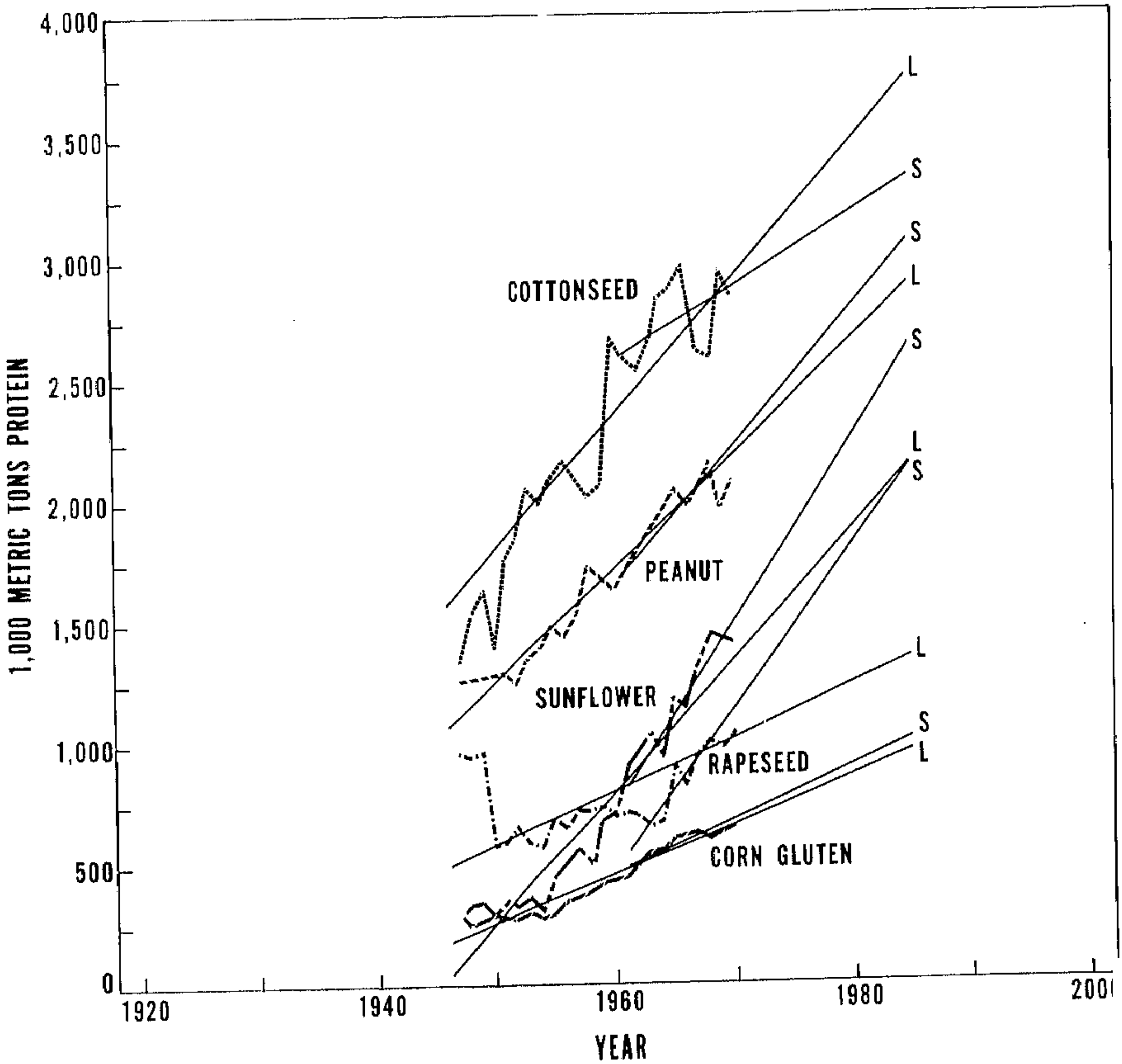

Figure 57.—World production of cottonseed, peanut, sunflower, rapeseed, and corn gluten proteins.

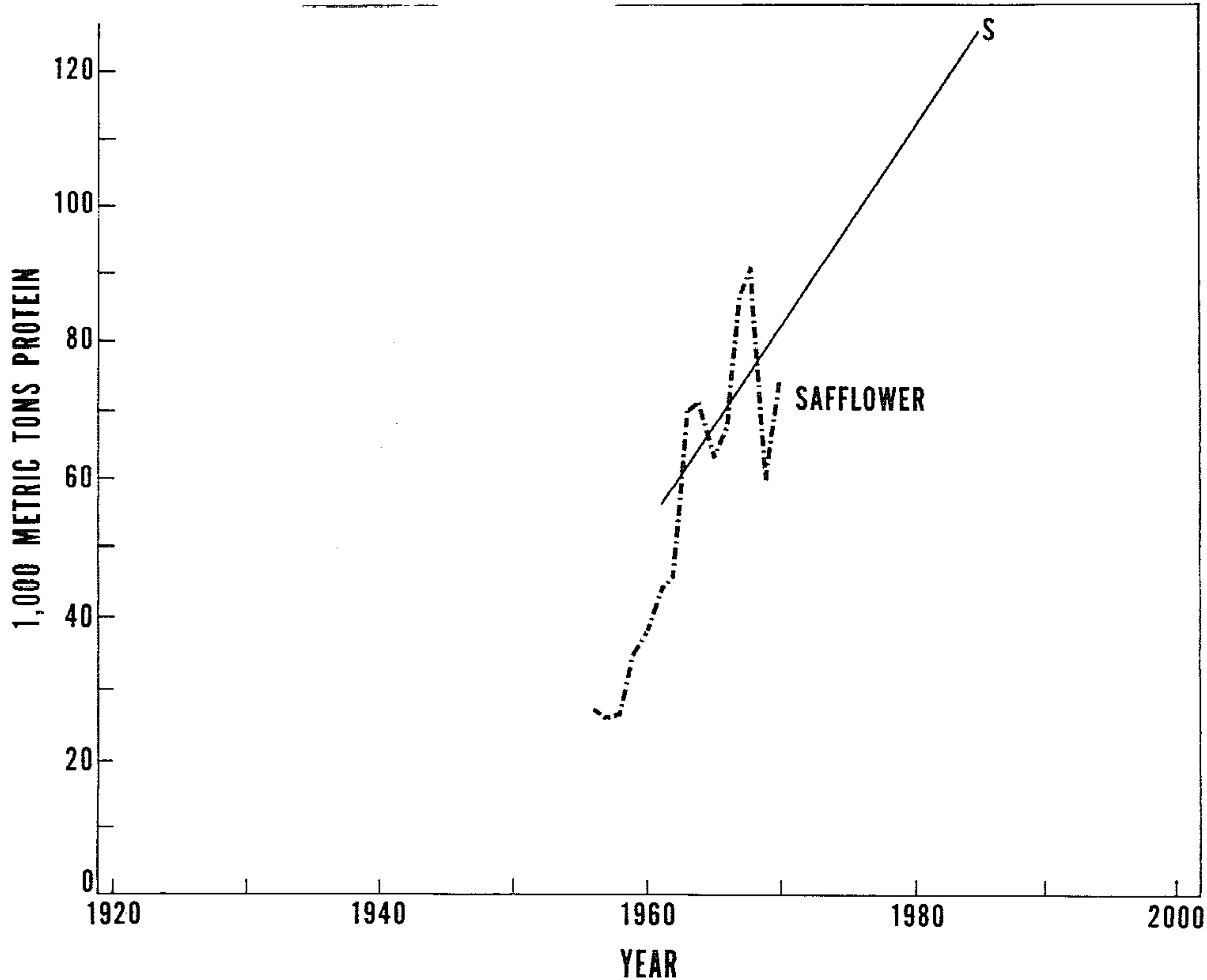

Figure 58.—World production of safflower protein.

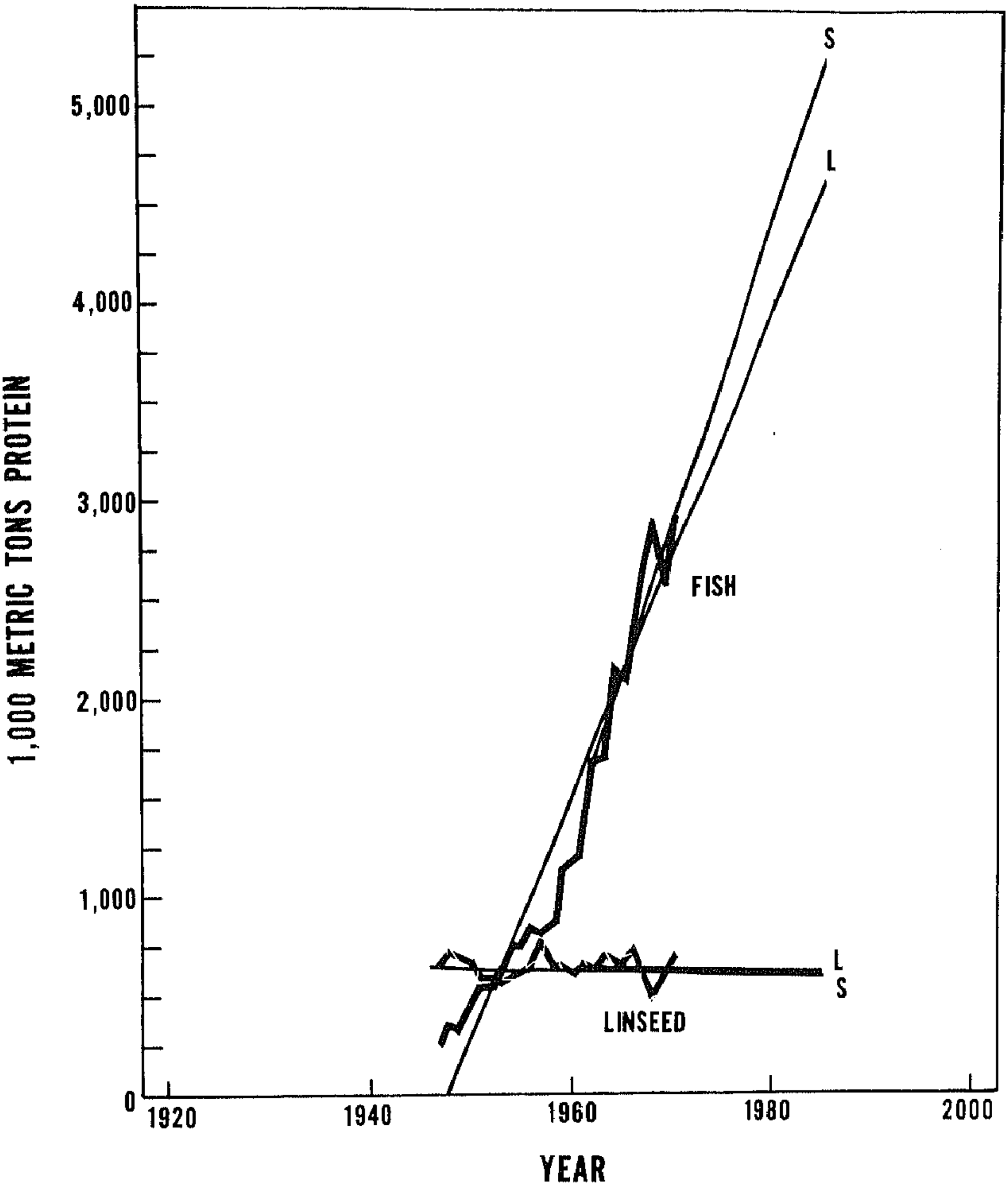

Figure 59.—World production of fishmeal and linseed proteins.

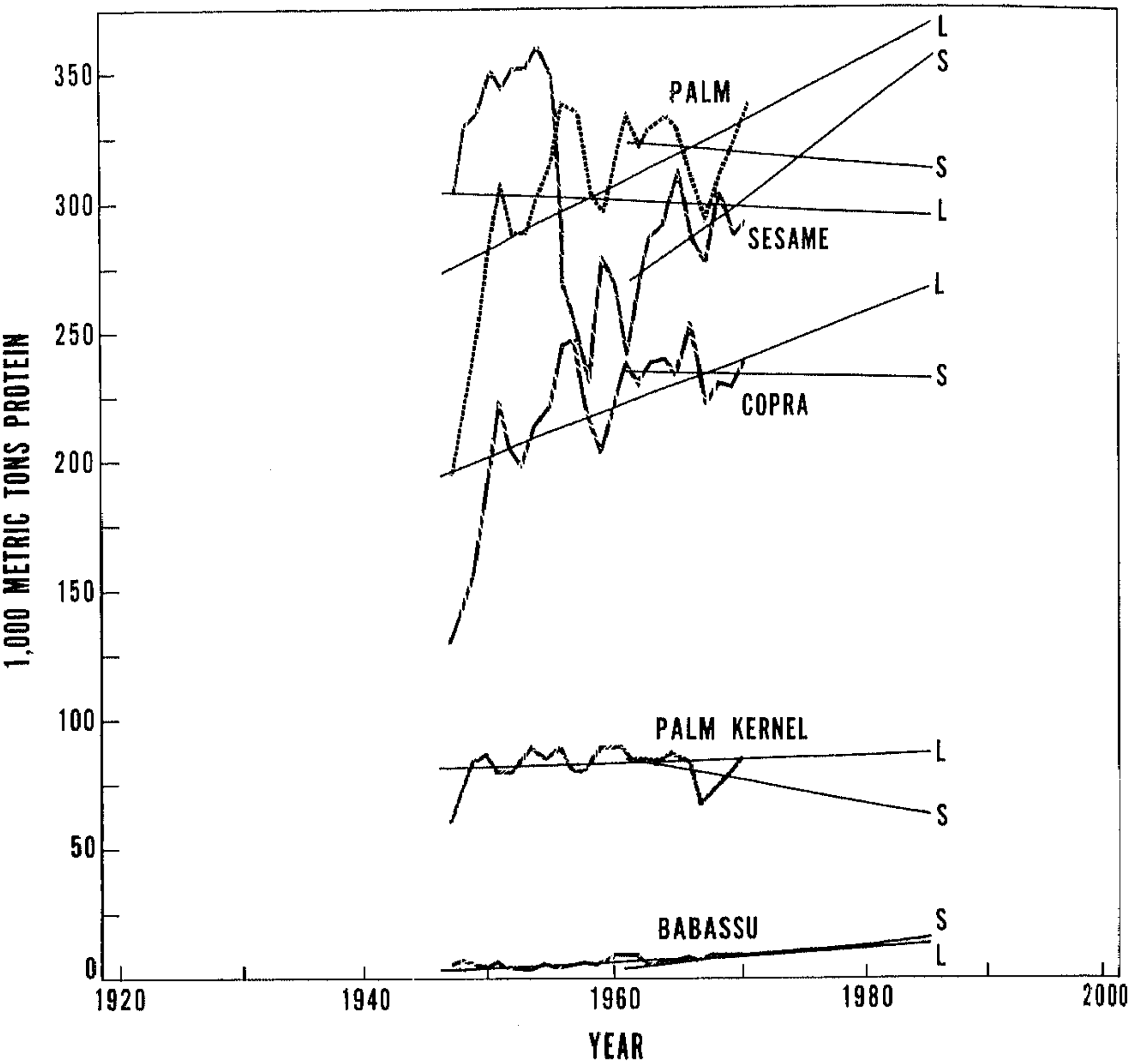

Figure 60.—World production of palm, sesame, copra, palm kernel, and babassu proteins.

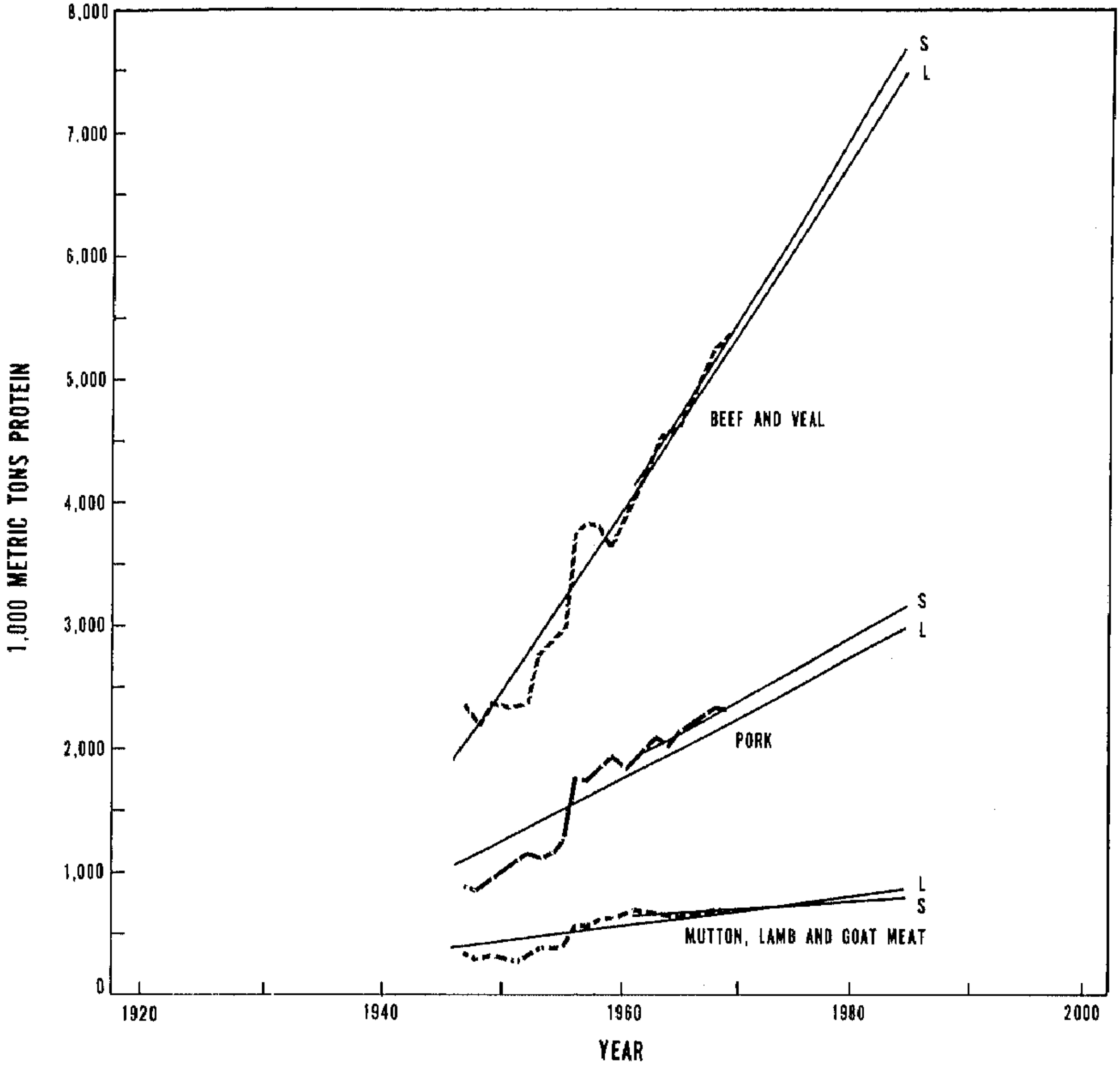

Figure 61.—World production of beef, veal, pork, mutton, lamb, and goat meat proteins.

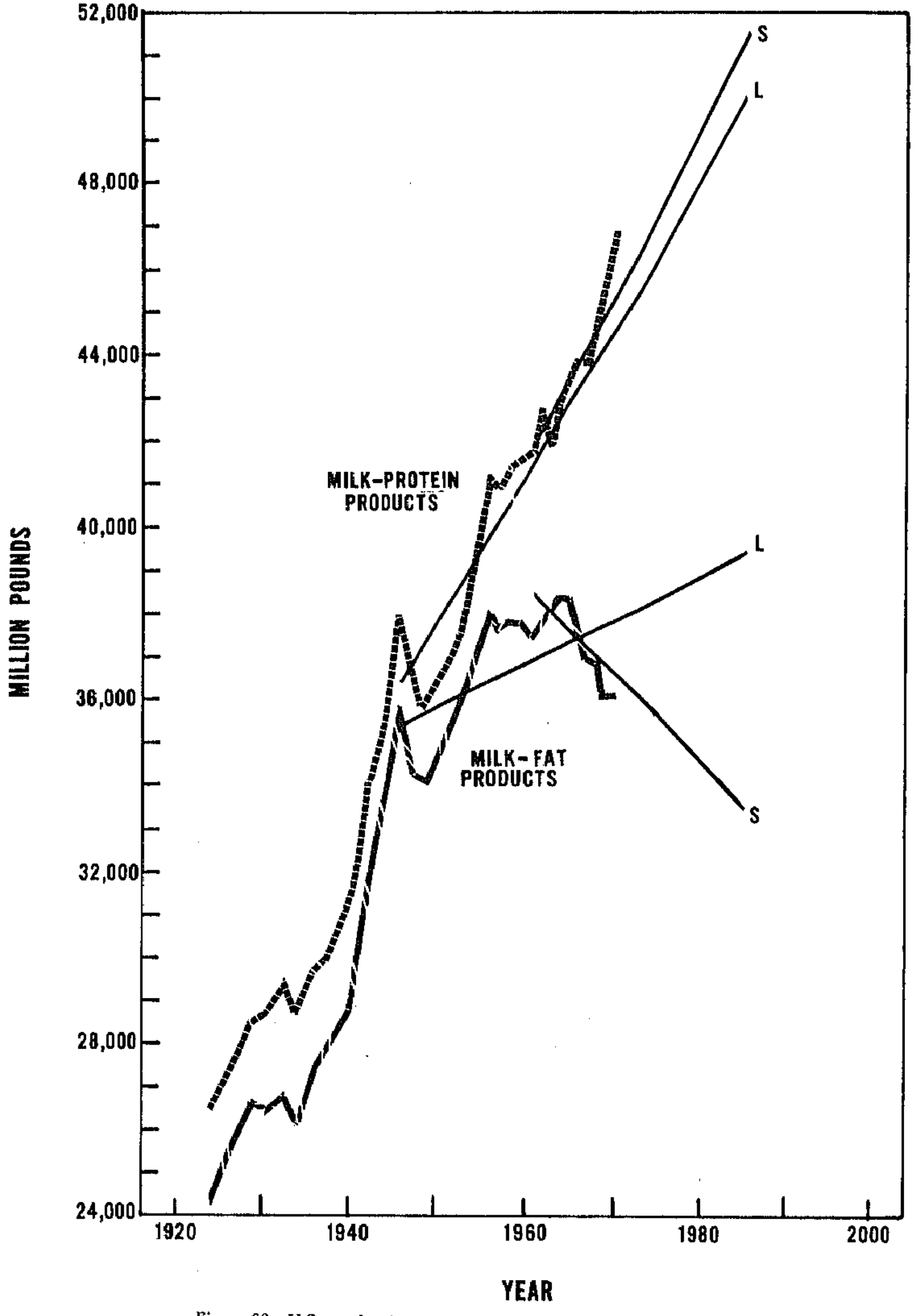

Figure 62.—U.S. production of milk-fat and milk-protein products.

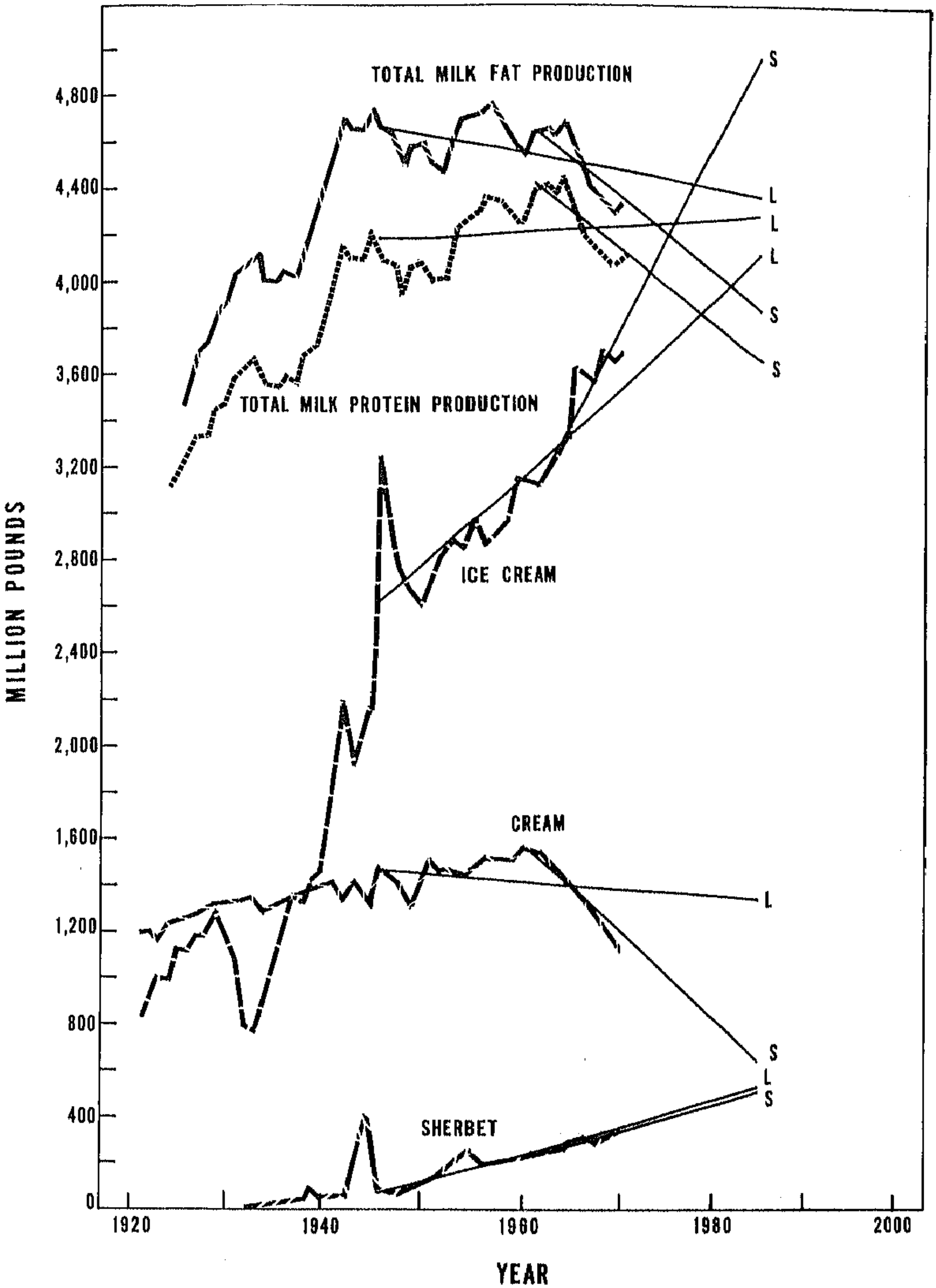

Figure 63.--U.S. production of milk fat, milk protein, ice cream, cream, and sherbet.

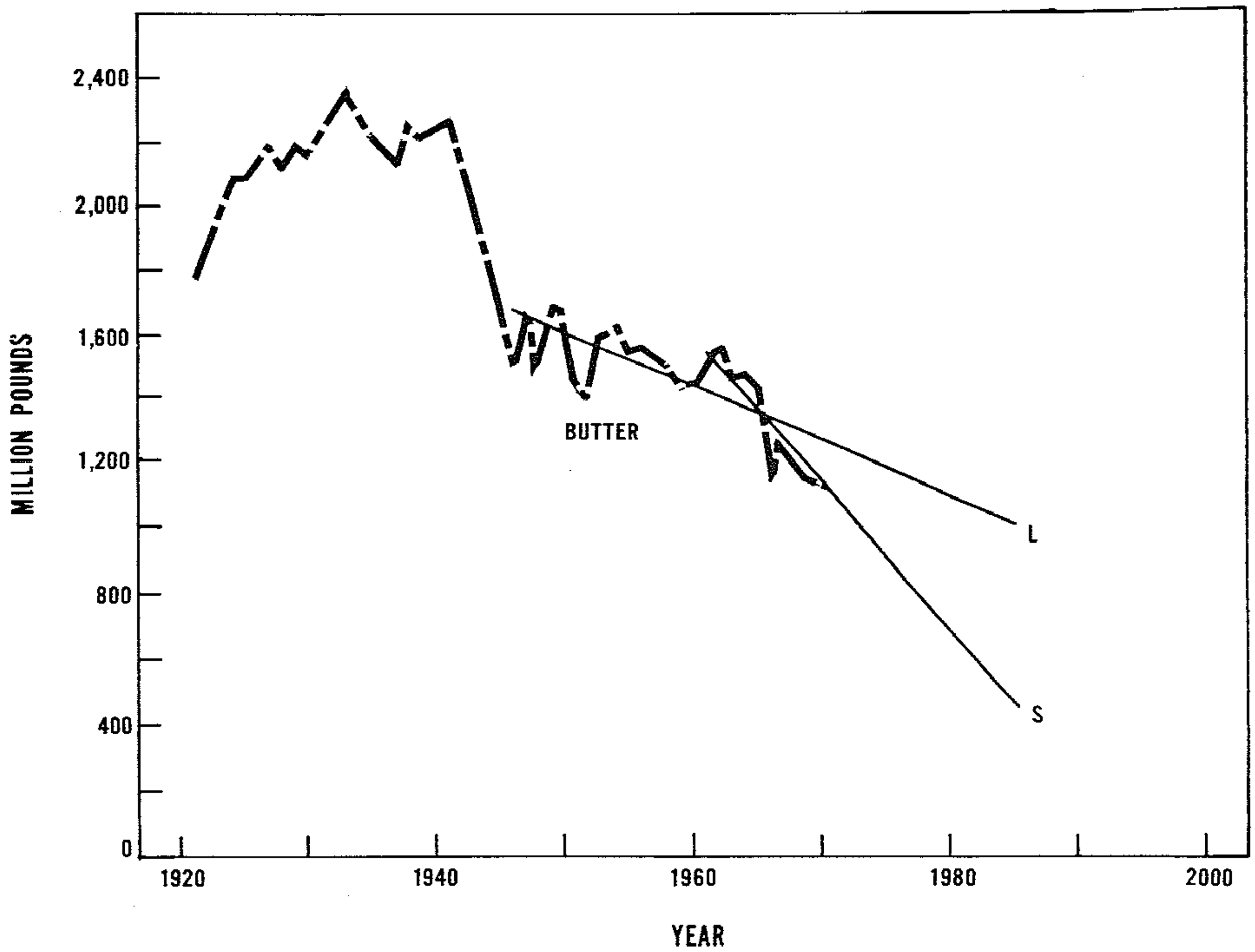

Figure 64.—U.S. production of butter.

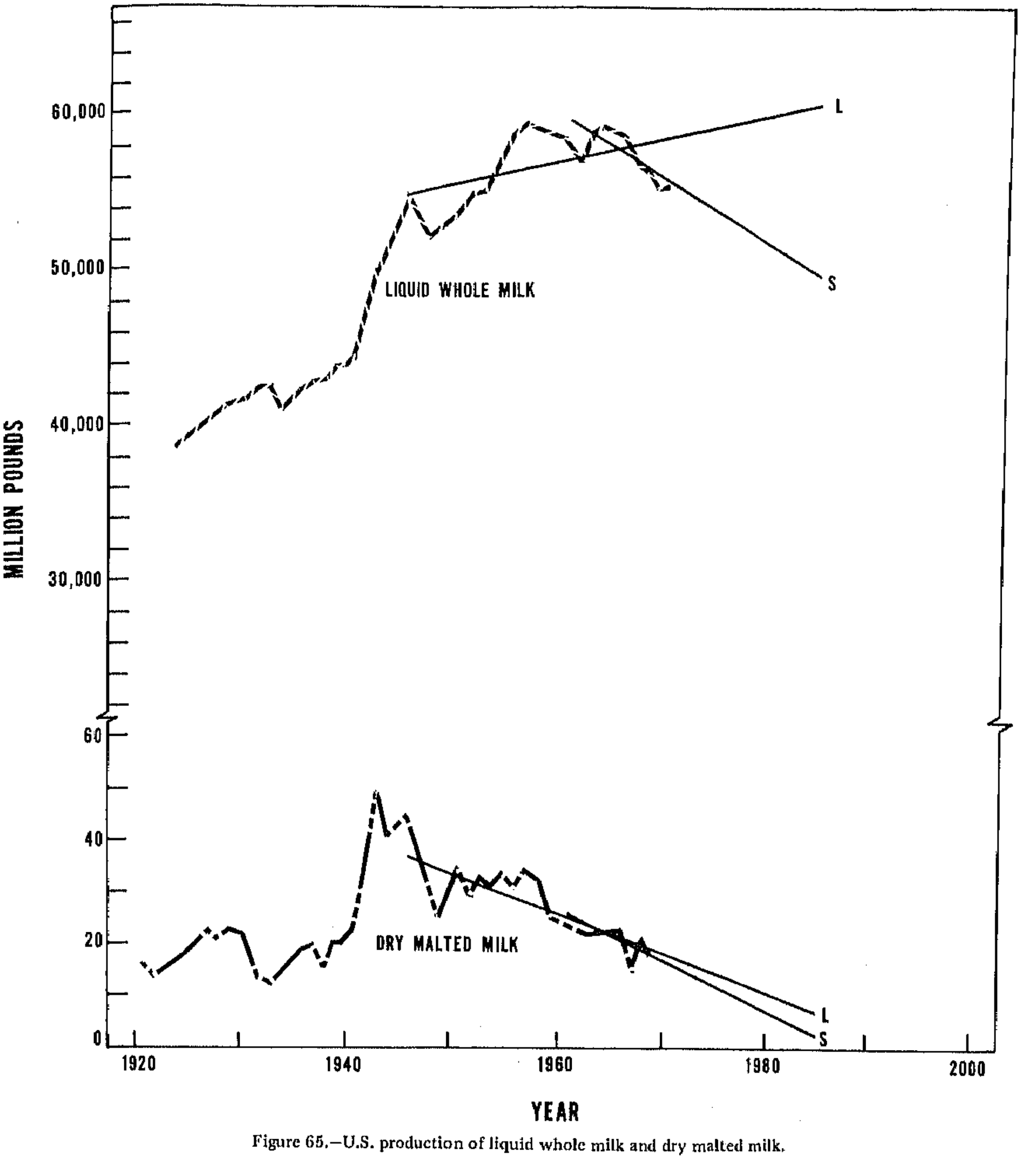

Figure 65.—U.S. production of liquid whole milk and dry malted milk.

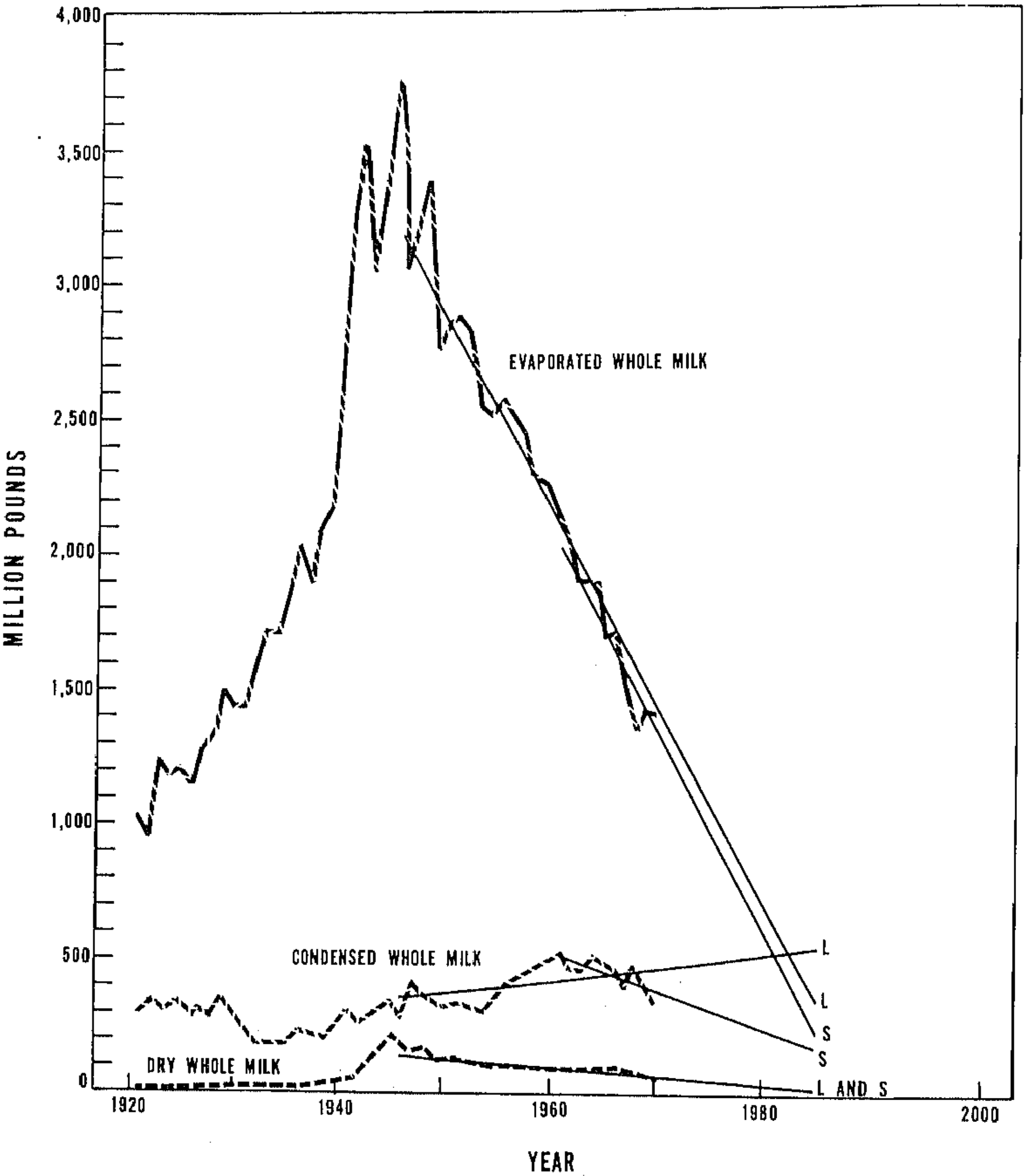

Figure 66.—U.S. production of evaporated whole milk, condensed whole milk, and dry whole milk.

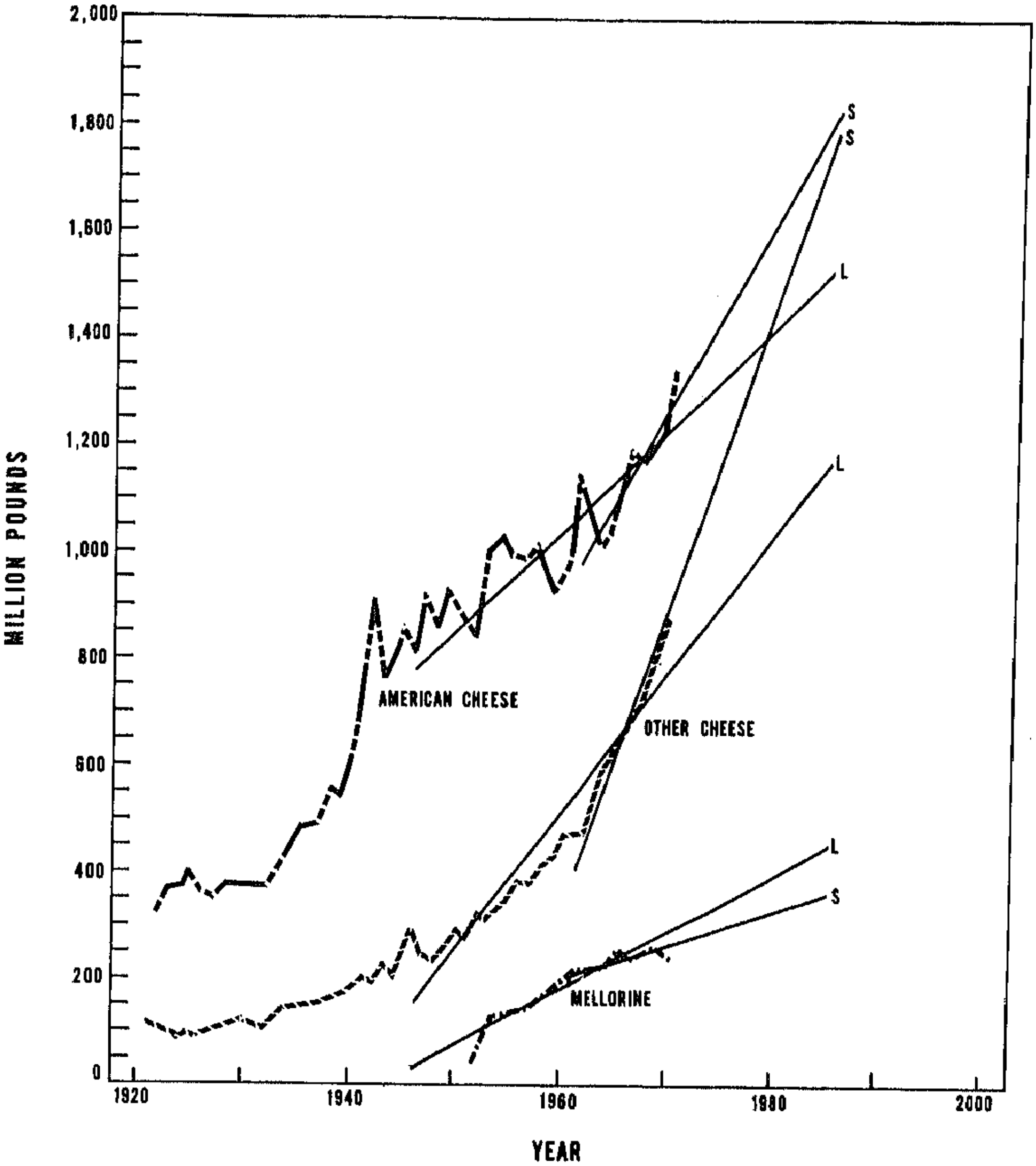

Figure 67.–U.S. production of low-fat milk.

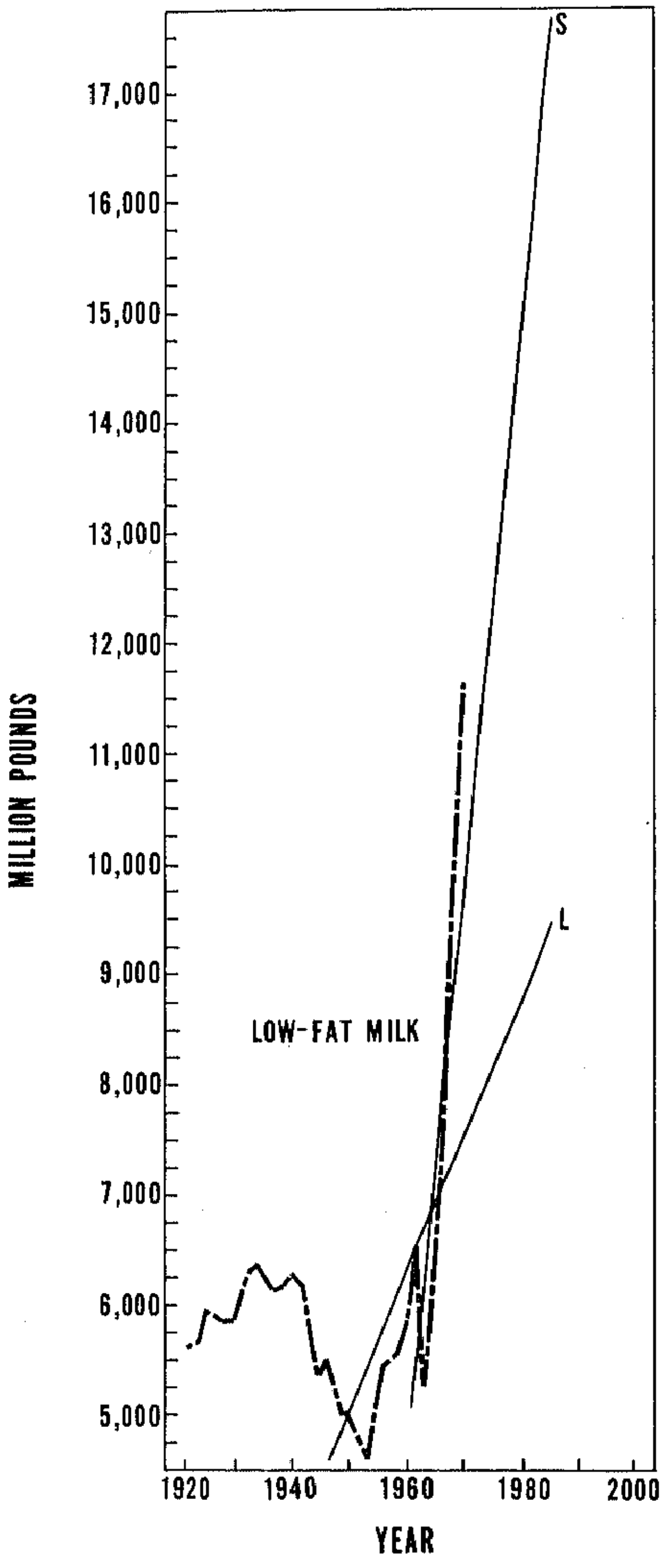

Figure 68.—U.S. production of nonfat dry milk.

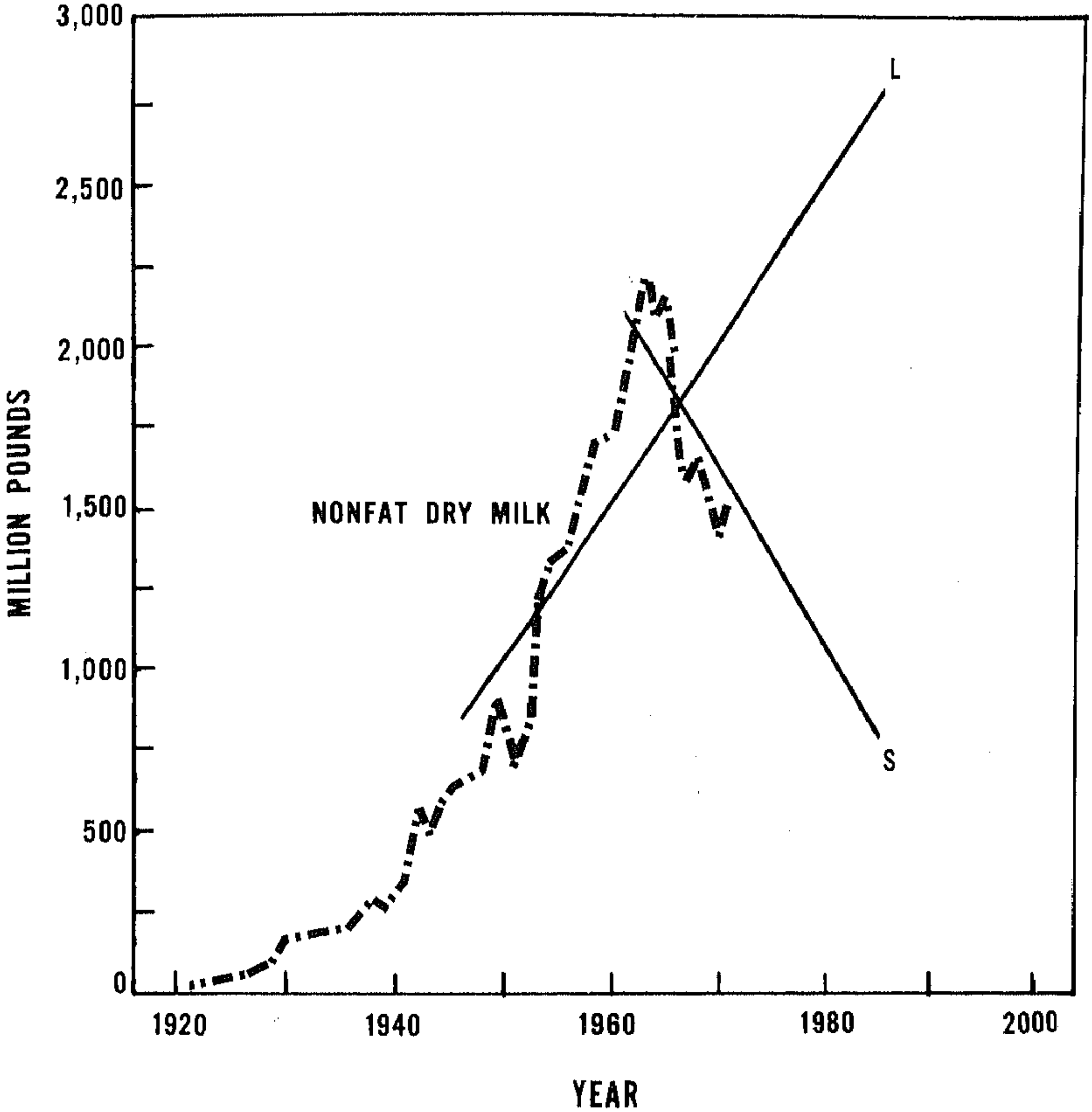

Figure 69.—U.S. production of American cheese, other cheese, and mellorine.

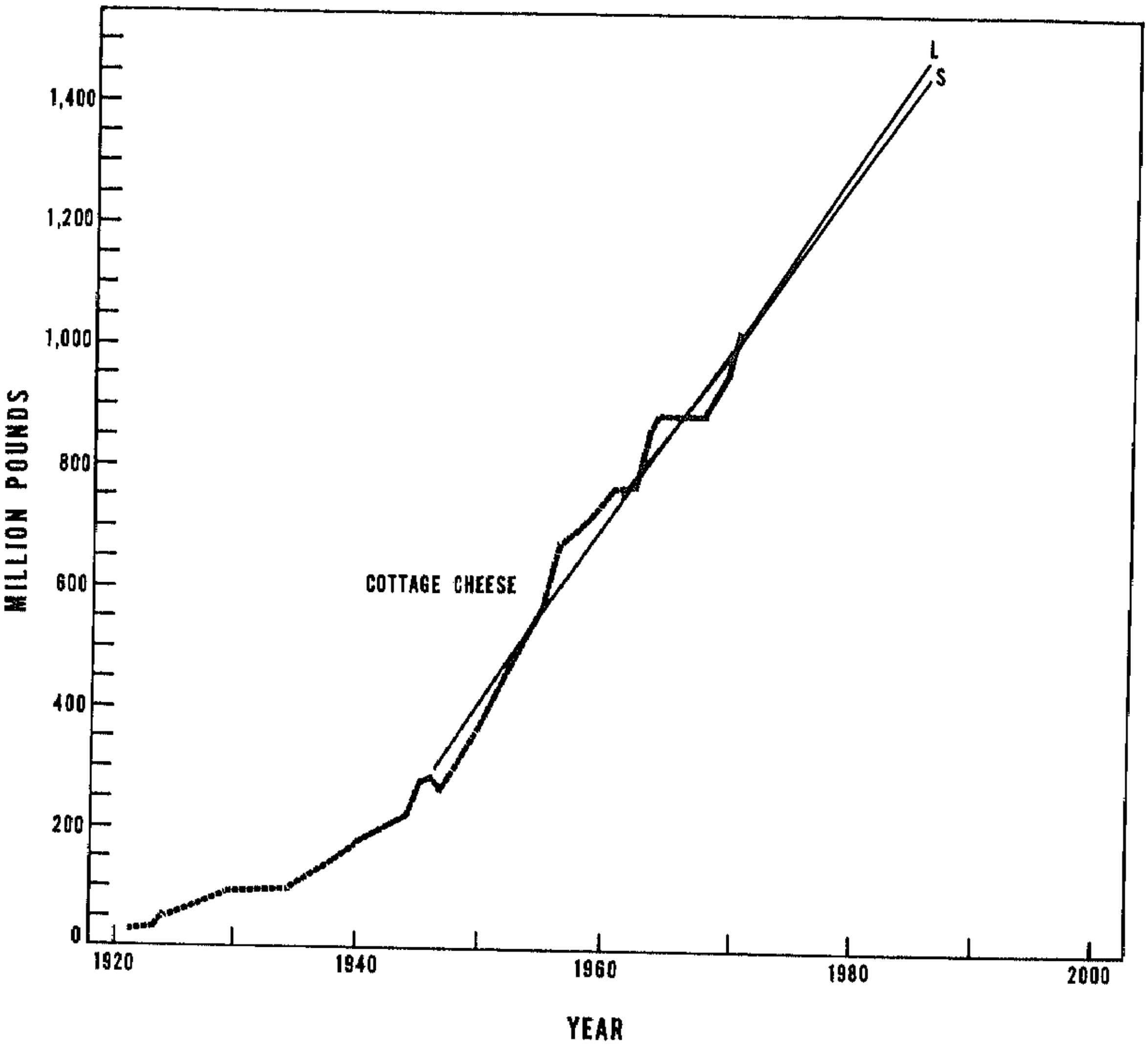

Figure 70.—U.S. production of cottage cheese.

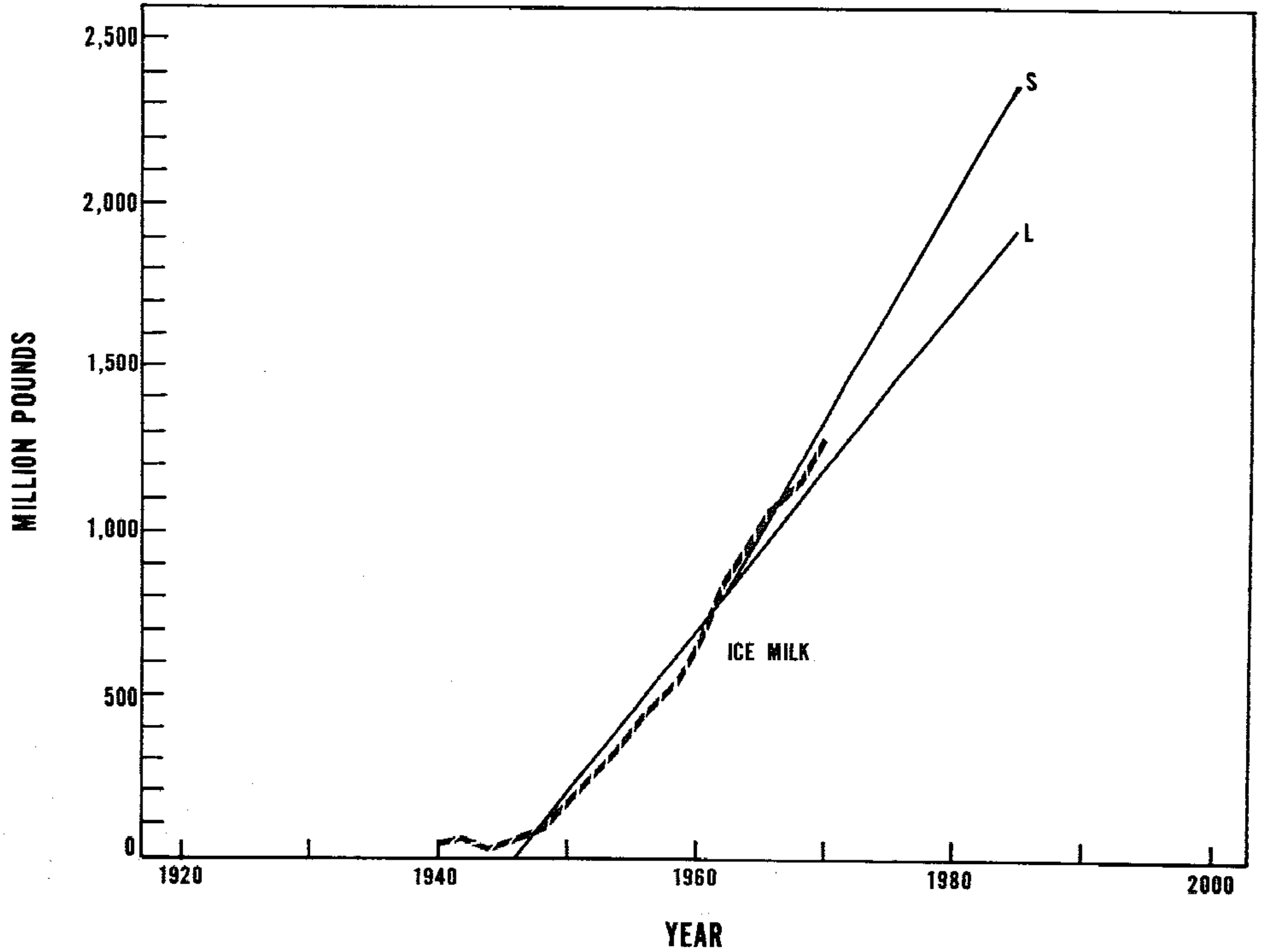

Figure 71.—U.S. production of ice milk.

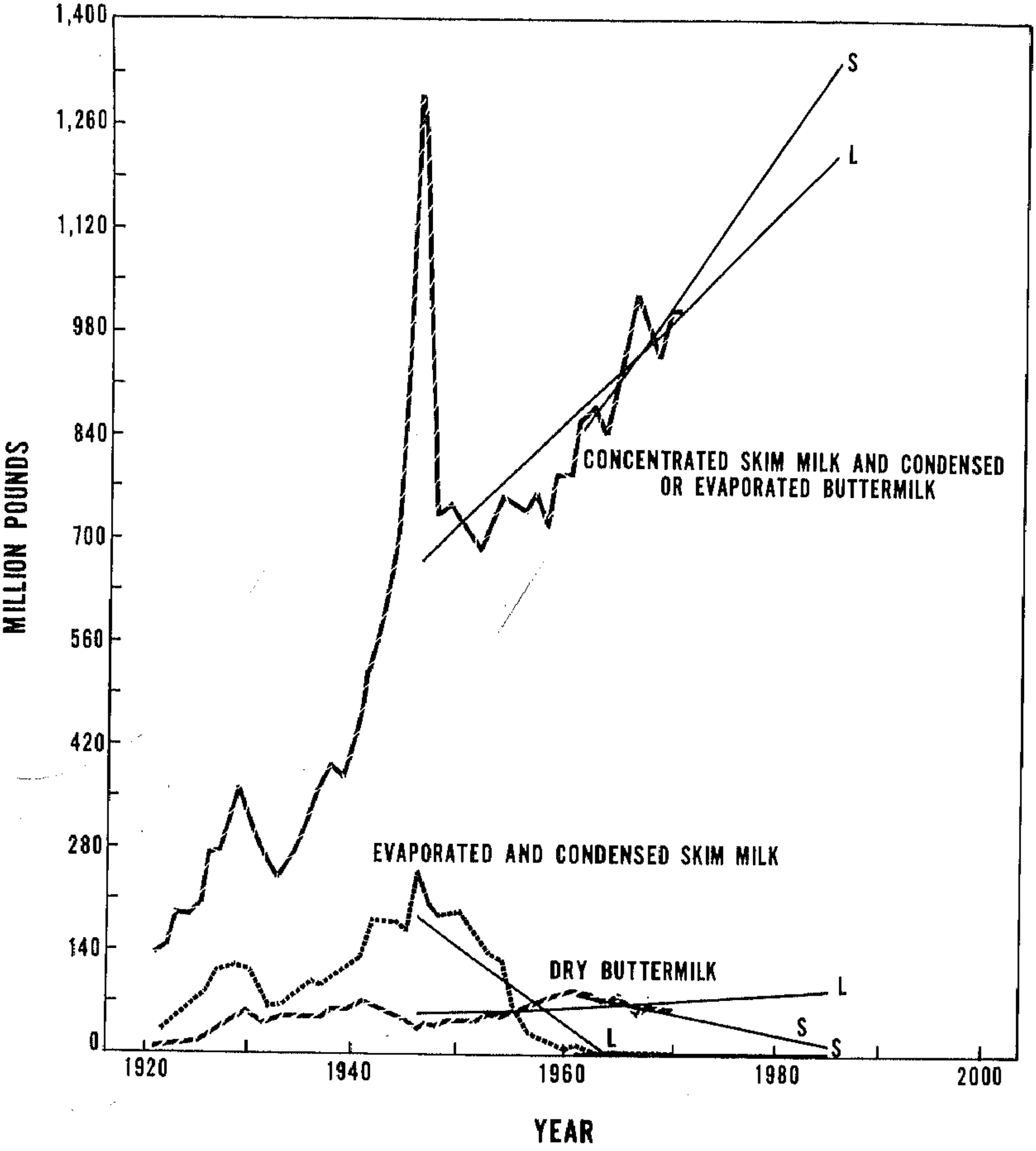

Figure 72.—U.S. production of evaporated and condensed skim milk, concentrated skim milk, condensed or evaporated buttermilk, and dry buttermilk.

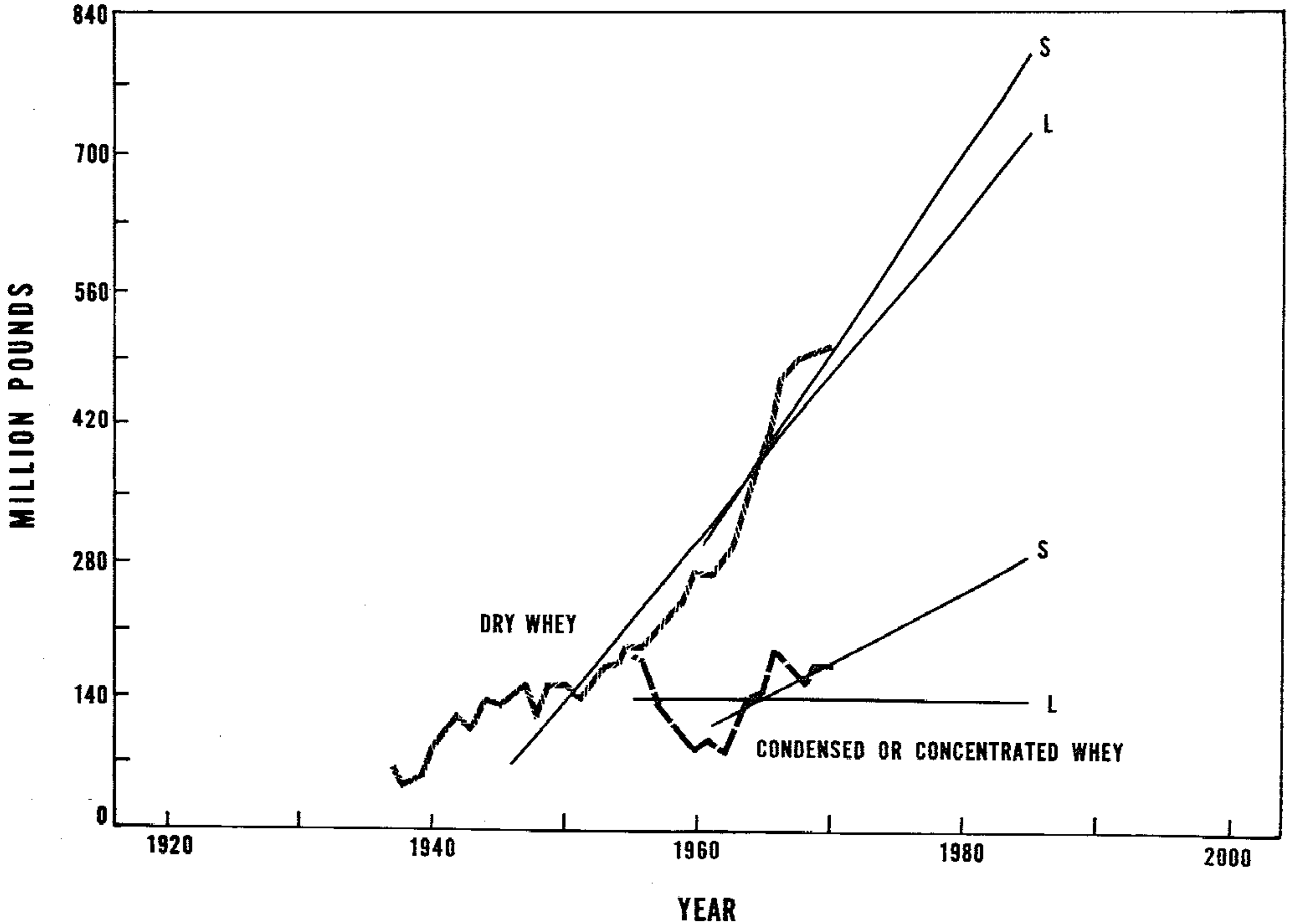

Figure 73.—U.S. production of dry, condensed, and concentrated whey.

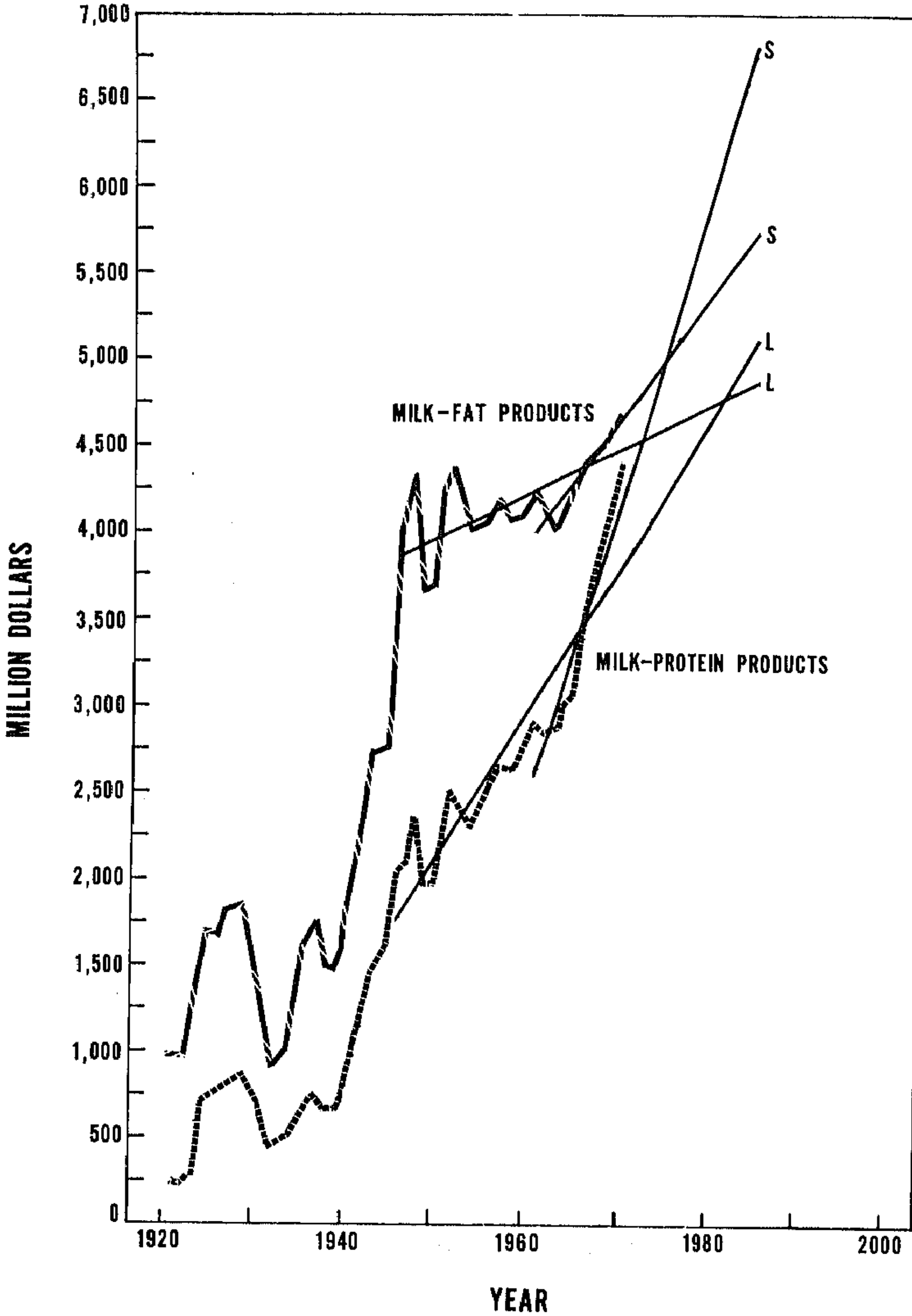

Figure 74.—Value of U.S. milk-fat and milk-protein products.

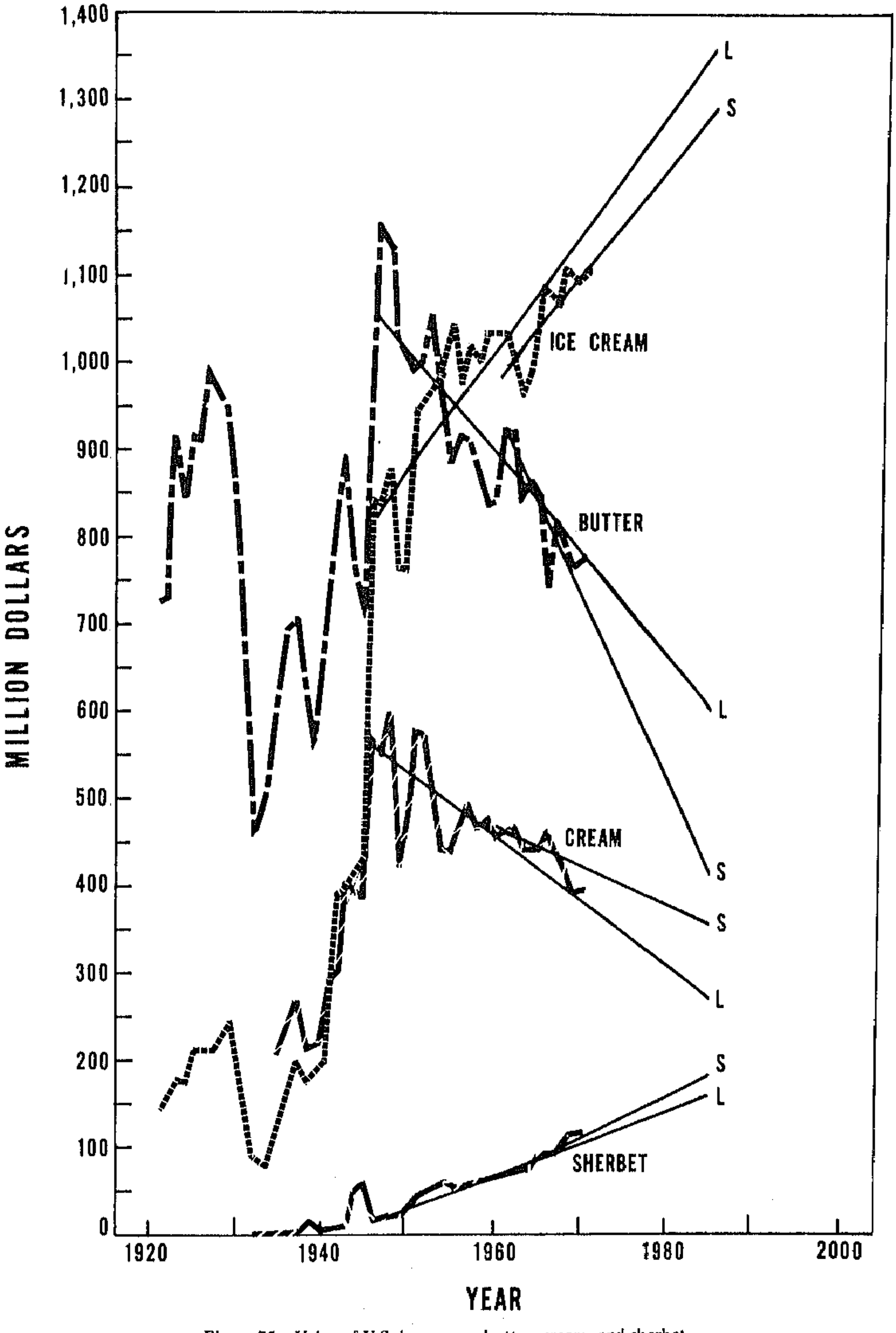

Figure 75.—Value of U.S. ice cream, butter, cream, and sherbet.

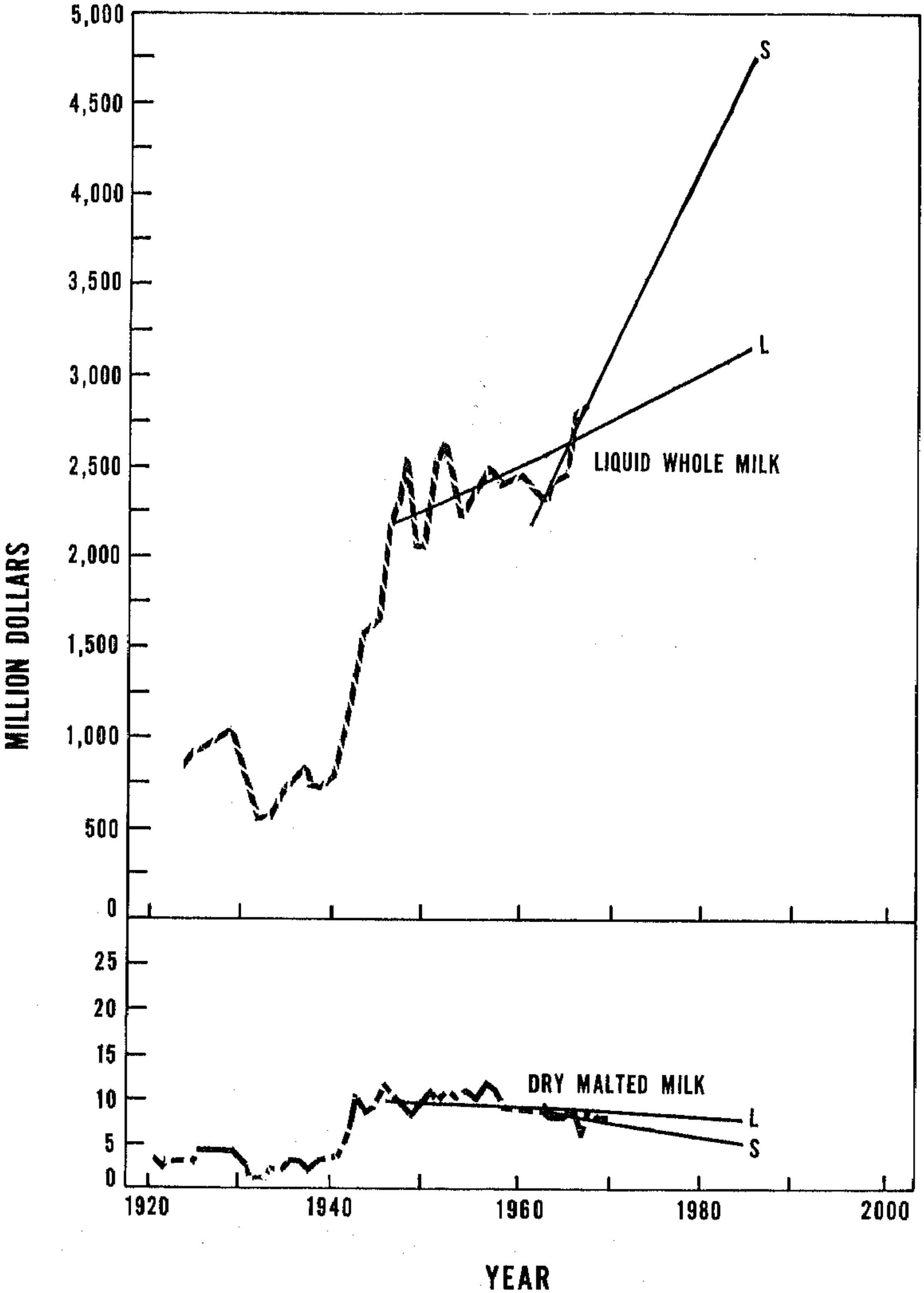

Figure 76.—Value of U.S. liquid whole milk and dry malted milk.

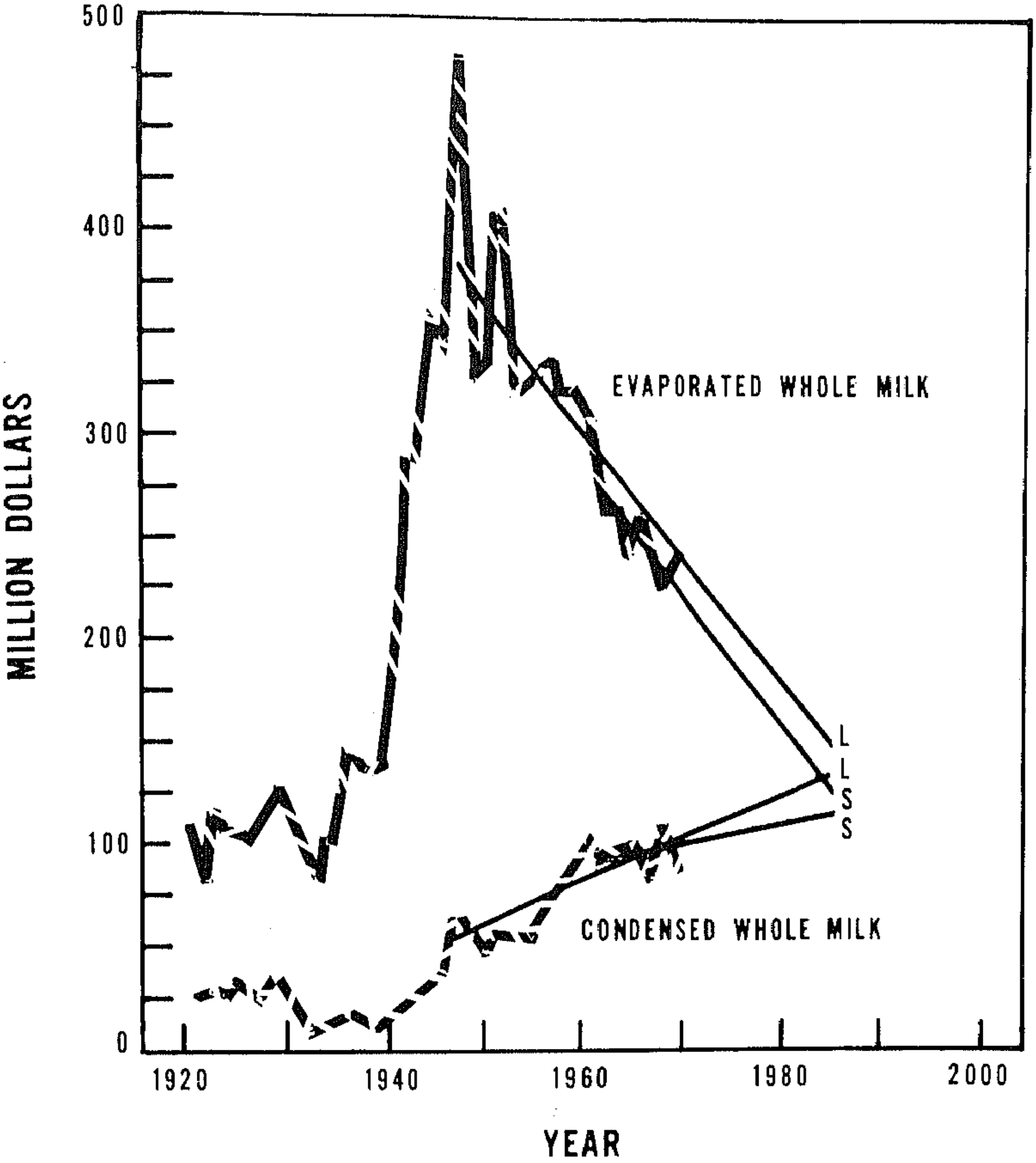

Figure 77.—Value of U.S. evaporated whole milk and condensed whole milk.

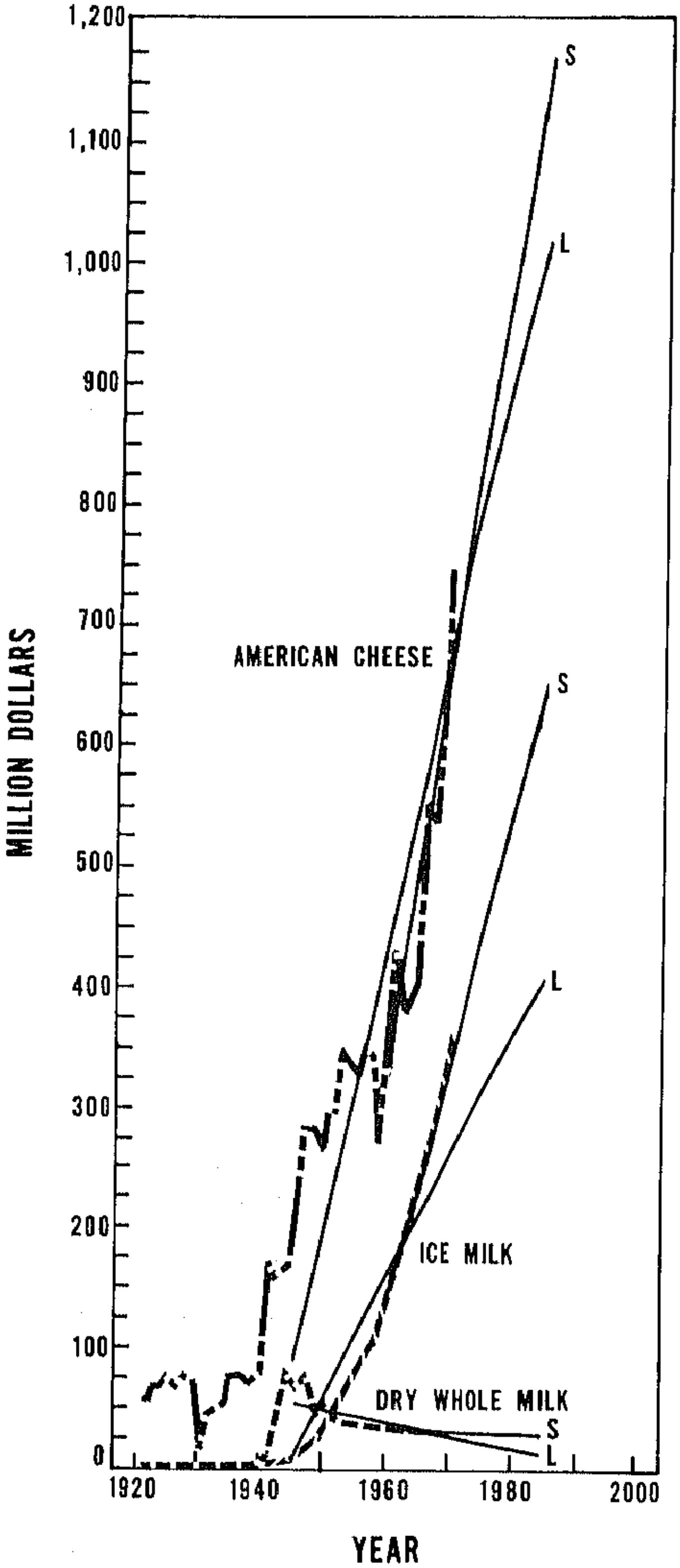

Figure 78.—Value of U.S. American cheese, ice milk, and dry whole milk.

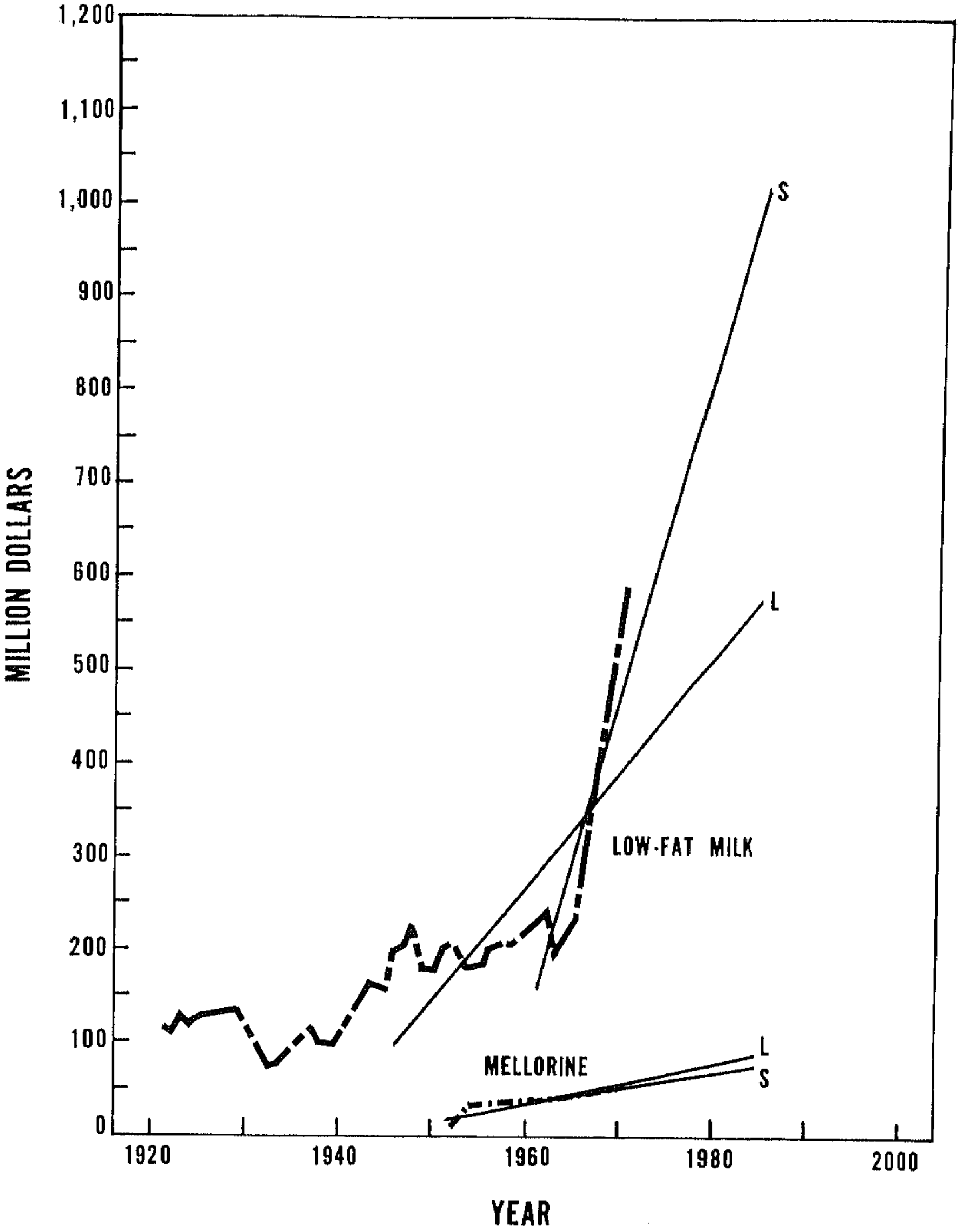

Figure 79.—Value of U.S. low-fat milk and mellorine.

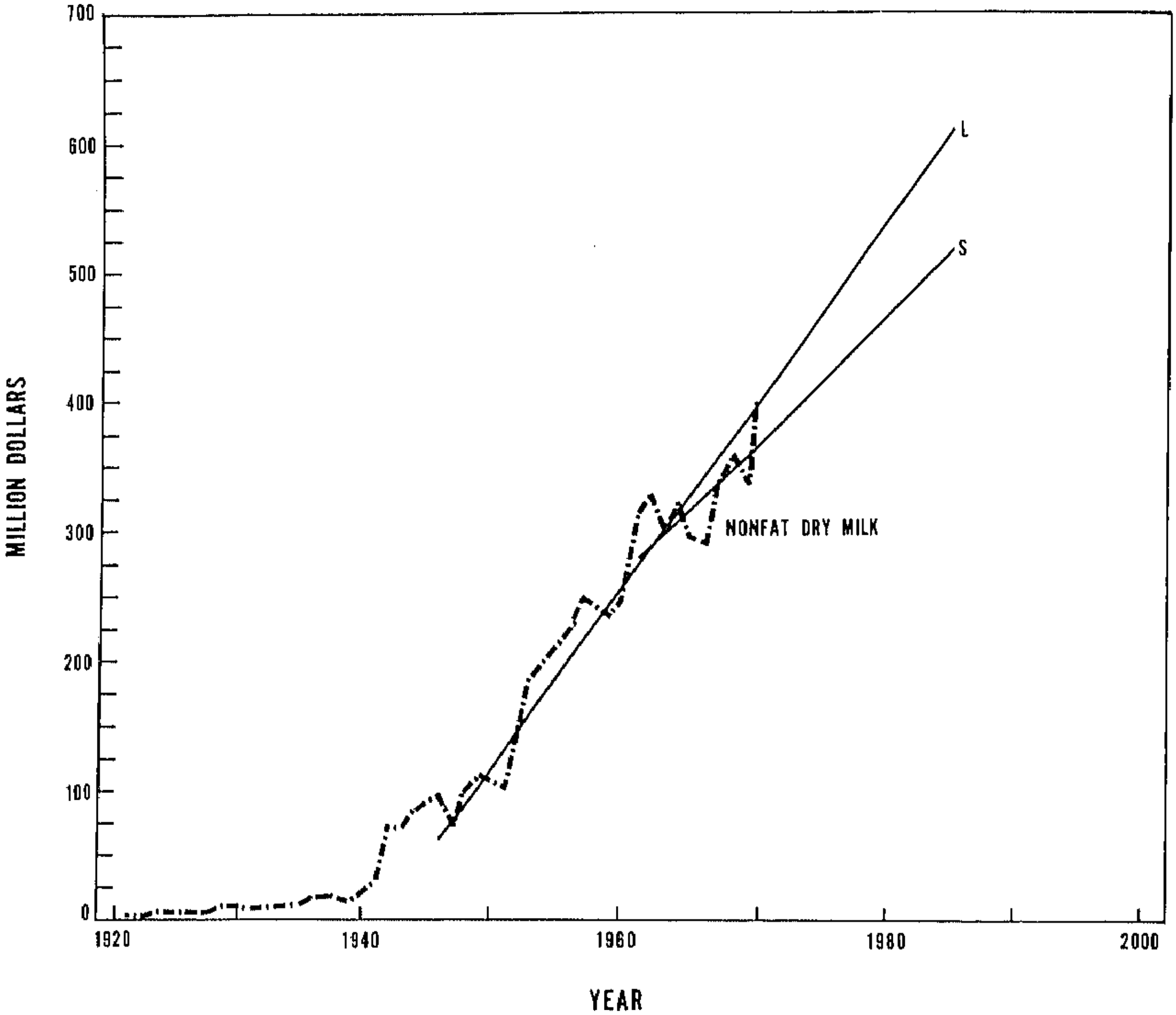

Figure 80.–Value of U.S. nonfat dry milk.

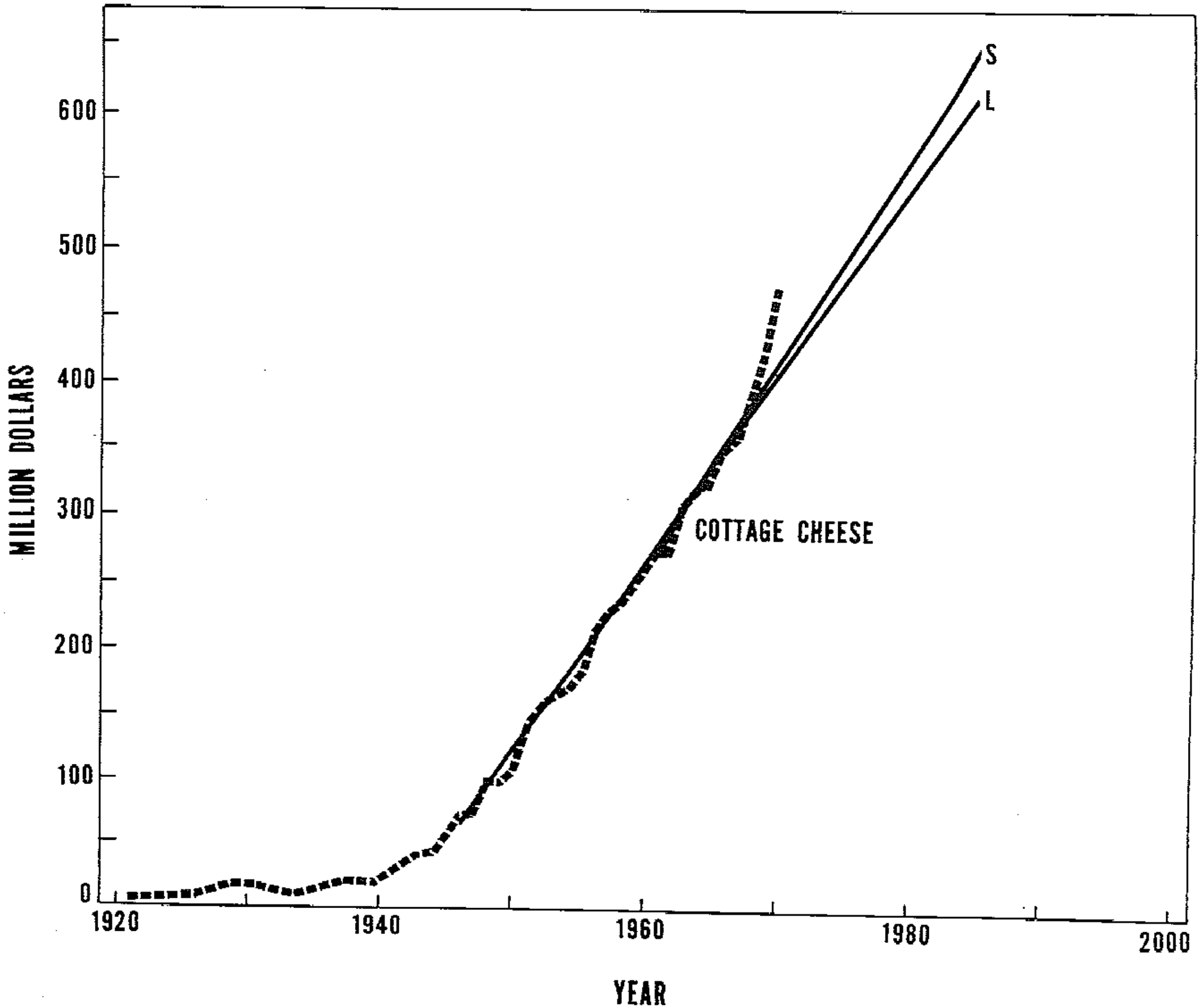

Figure 81.—Value of U.S. cottage cheese.

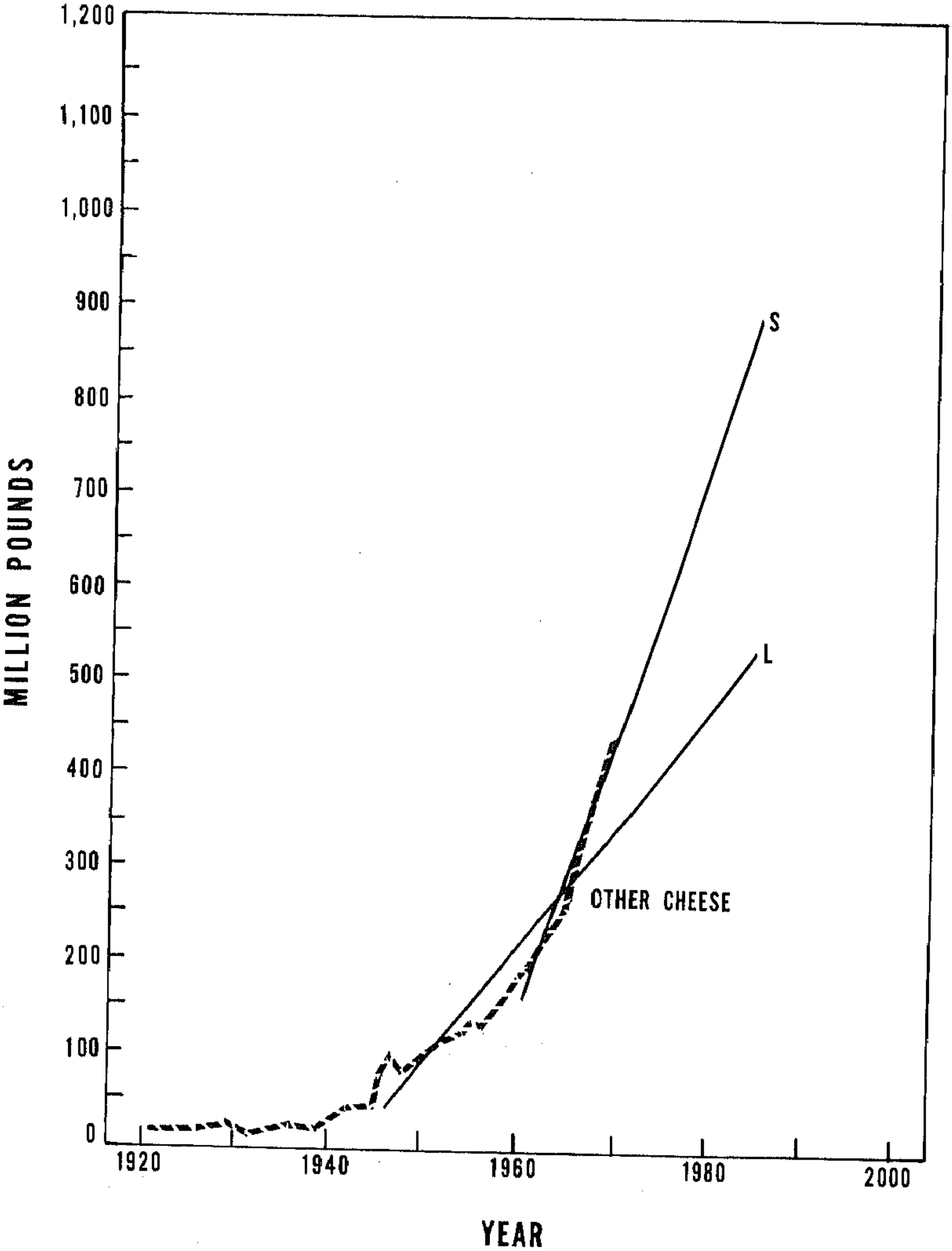

Figure 82.—Value of other U.S. cheese.

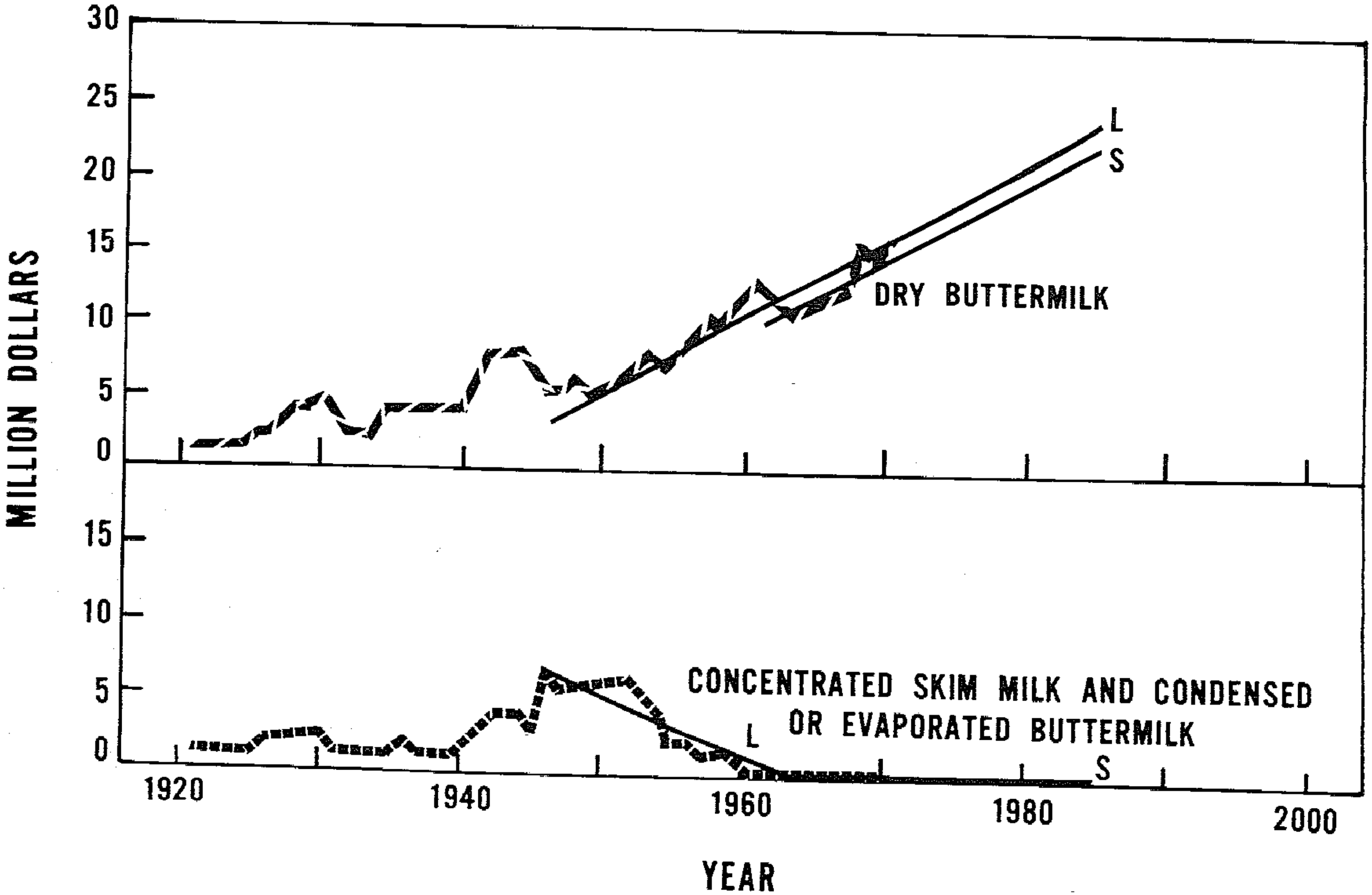

Figure 83.—Value of U.S. dry buttermilk, concentrated skim milk, and condensed or evaporated buttermilk.

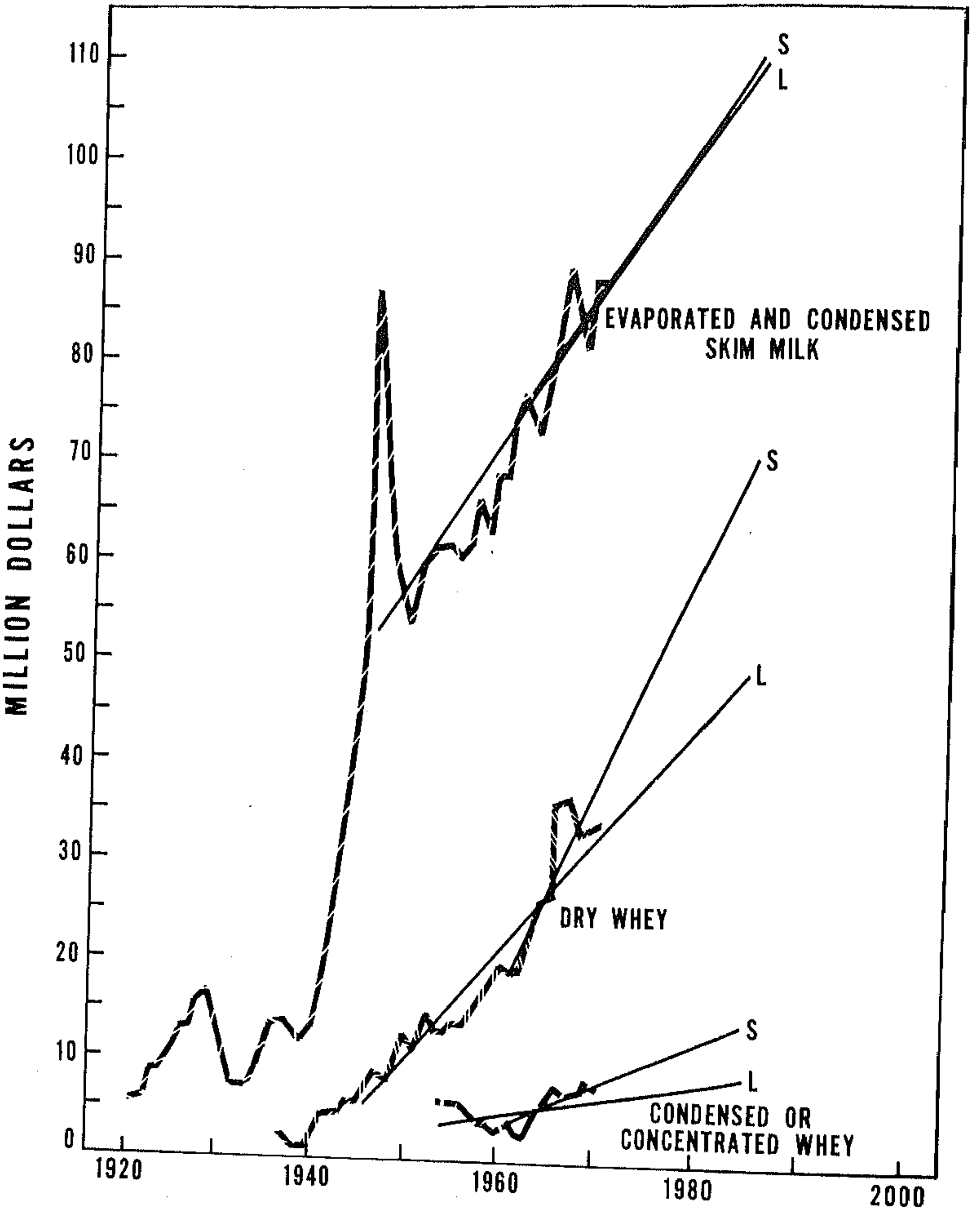

Figure 84.–Value of U.S. evaporated and condensed skim milk and dry, condensed, and concentrated whey.

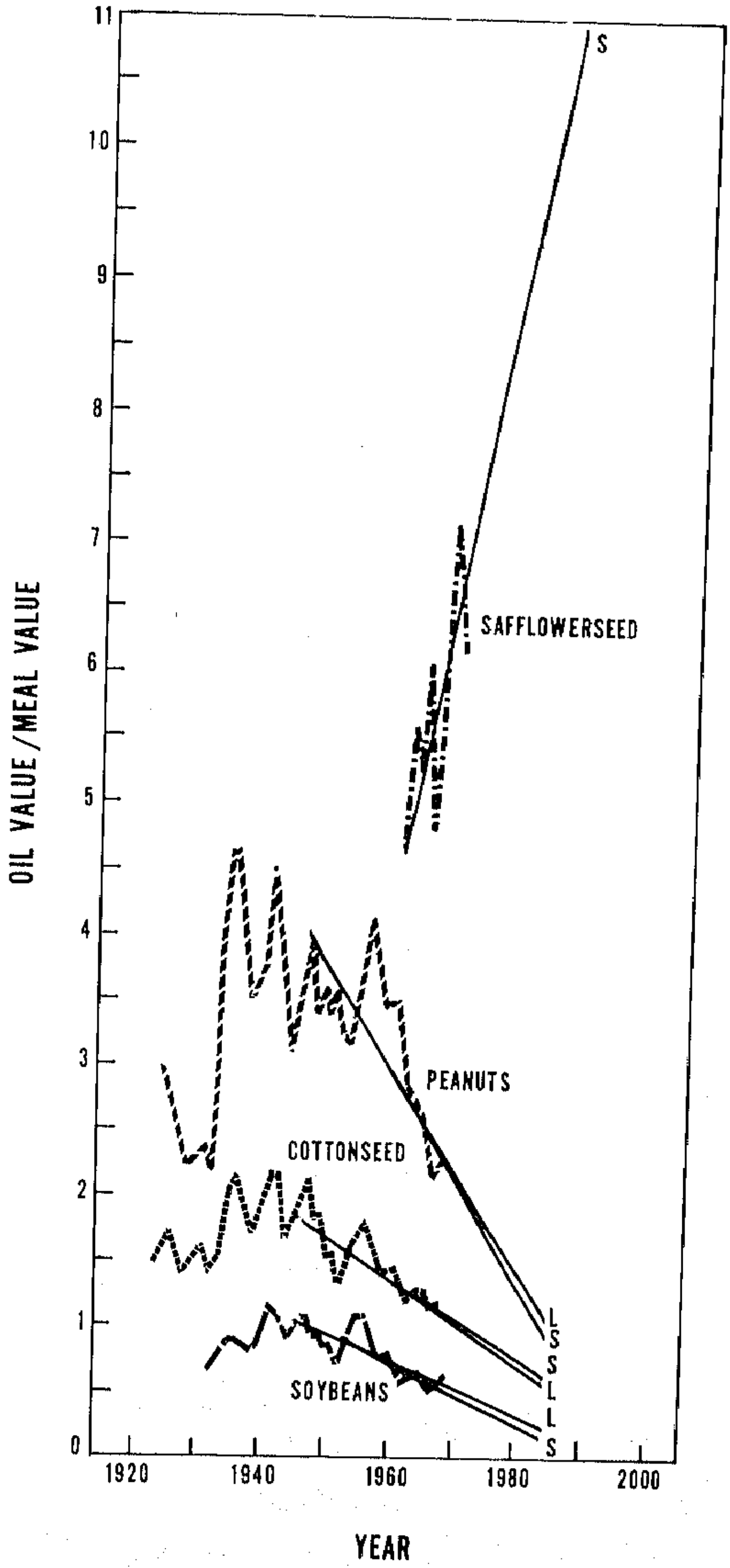

Figure 85.—Oil value/meal value for U.S. soybeans, cottonseed, peanuts, and safflower seed.

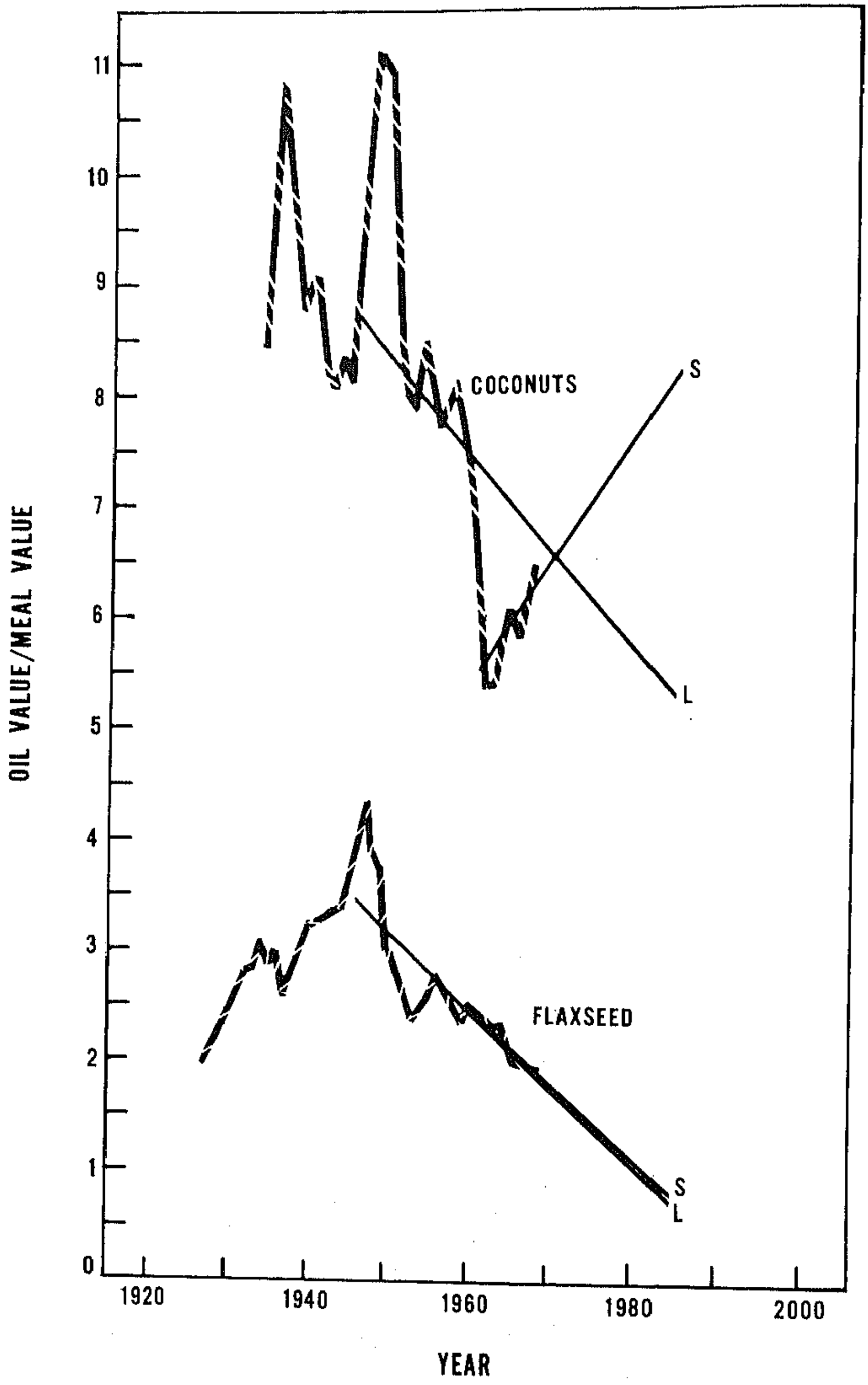

Figure 86.--Oil value/meal value for coconuts and flaxseed in the United States.

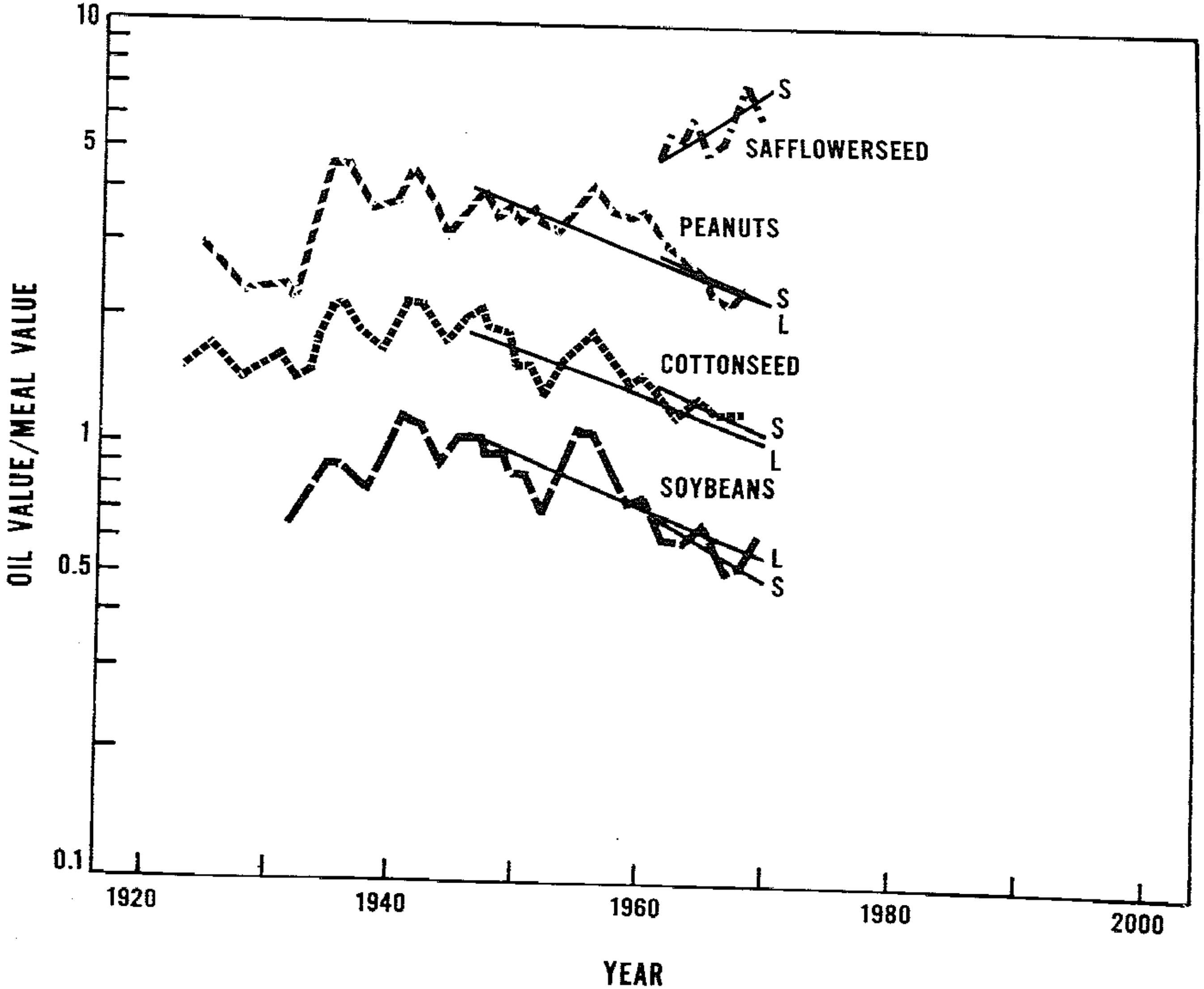

Figure 87.—Oil value/meal value for U.S. soybeans, cottonseed, peanuts, and safflowerseed (semilog plot for comparing rates of growth).

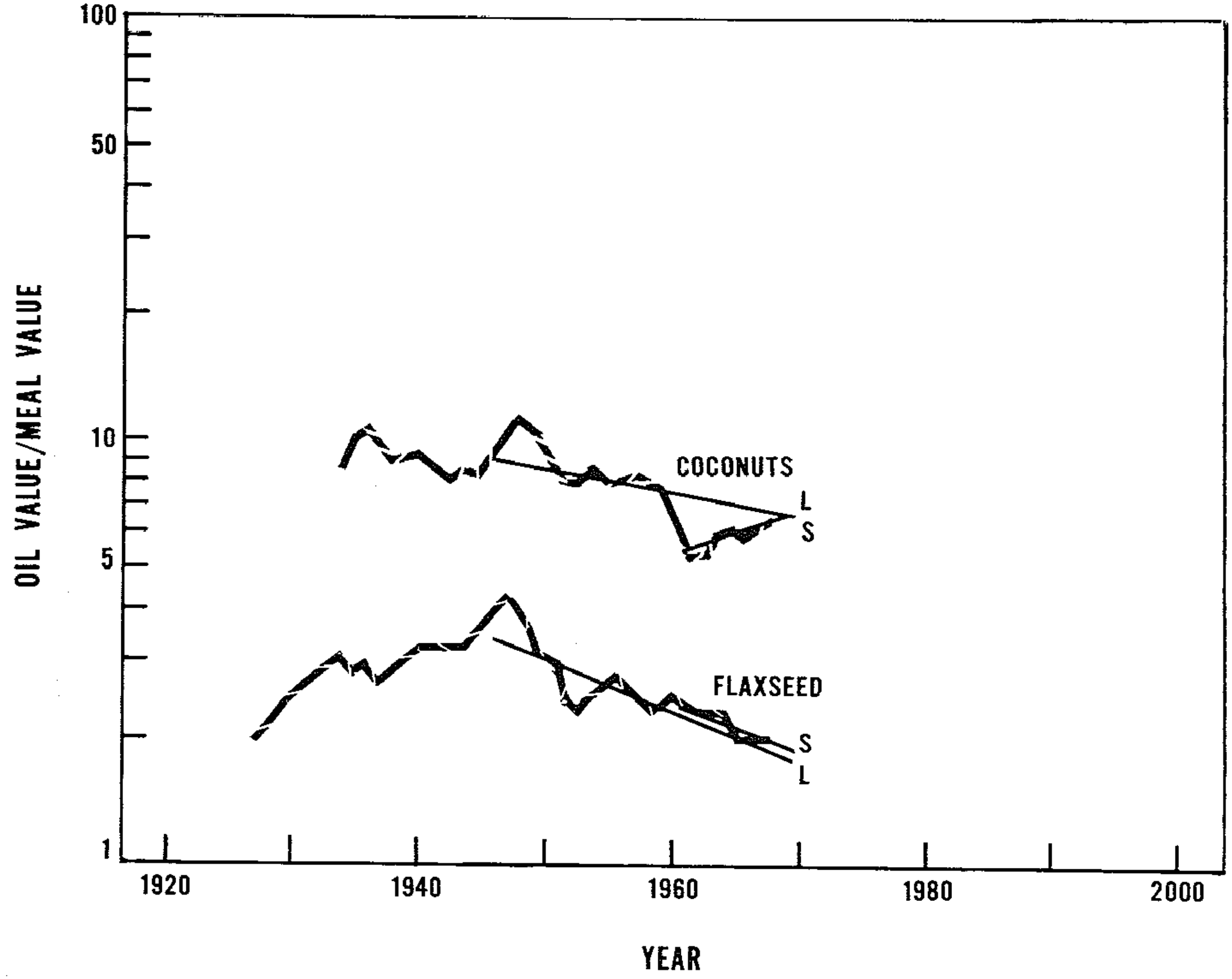

Figure 88.—Oil value/meal value for coconuts and flaxseed in the United States (semilog plot for comparing rates of growth).

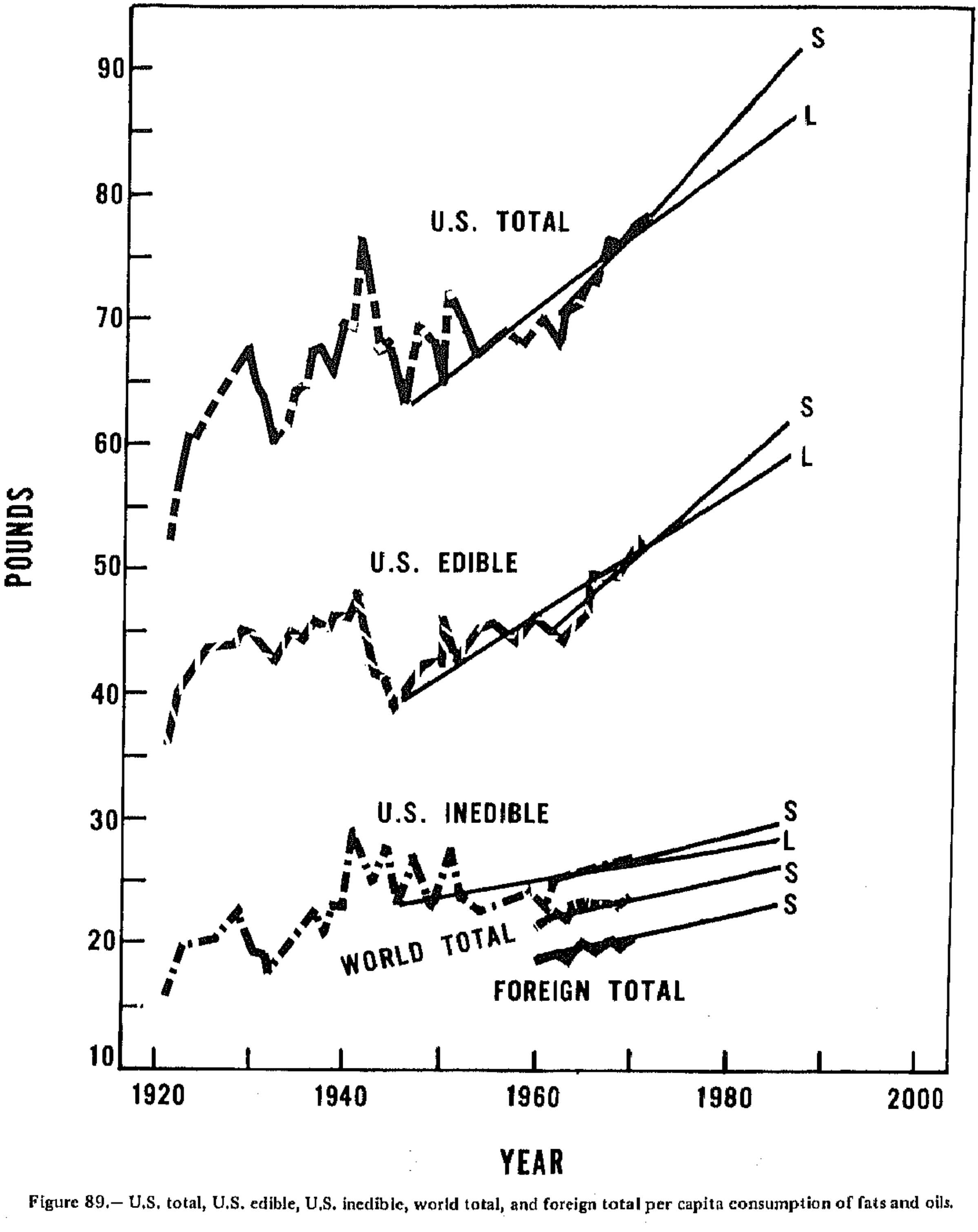

Figure 89.— U.S. total, U.S. edible, U.S. inedible, world total, and foreign total per capita consumption of fats and oils.

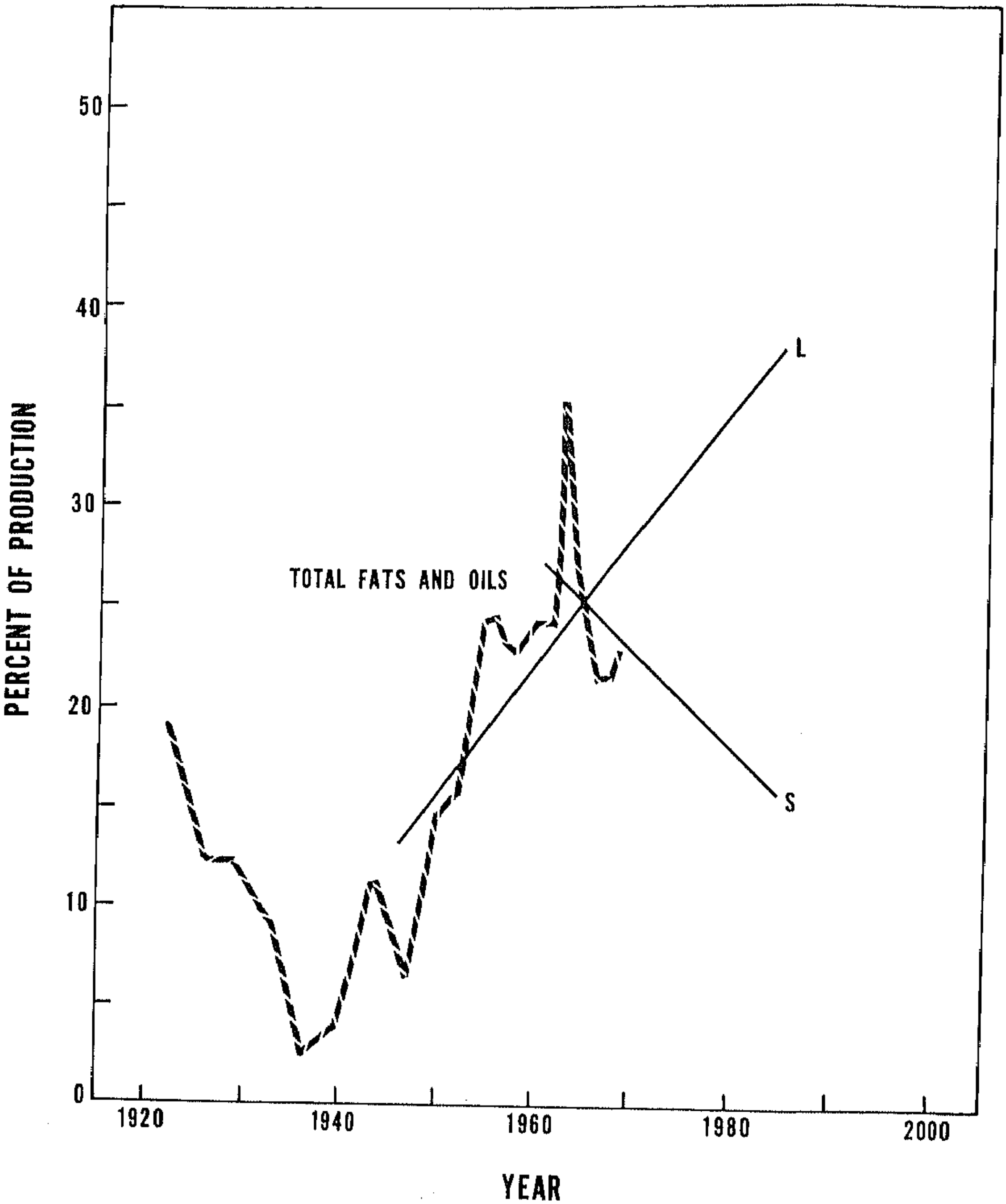

Figure 90.—Total fat and oil exports (3-year average).

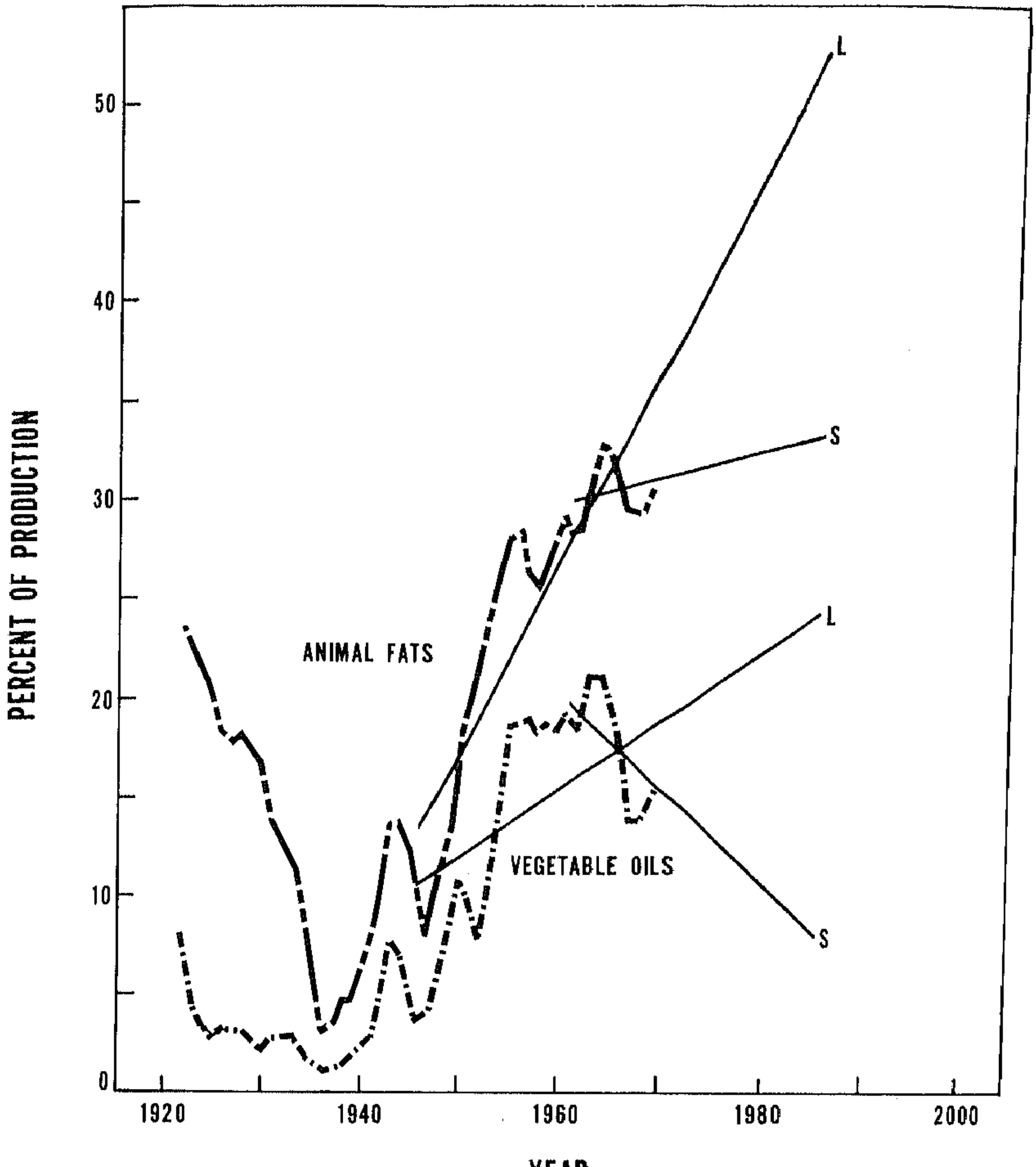

Figure 91.—Vegetable oil and animal fat exports (3-year average).

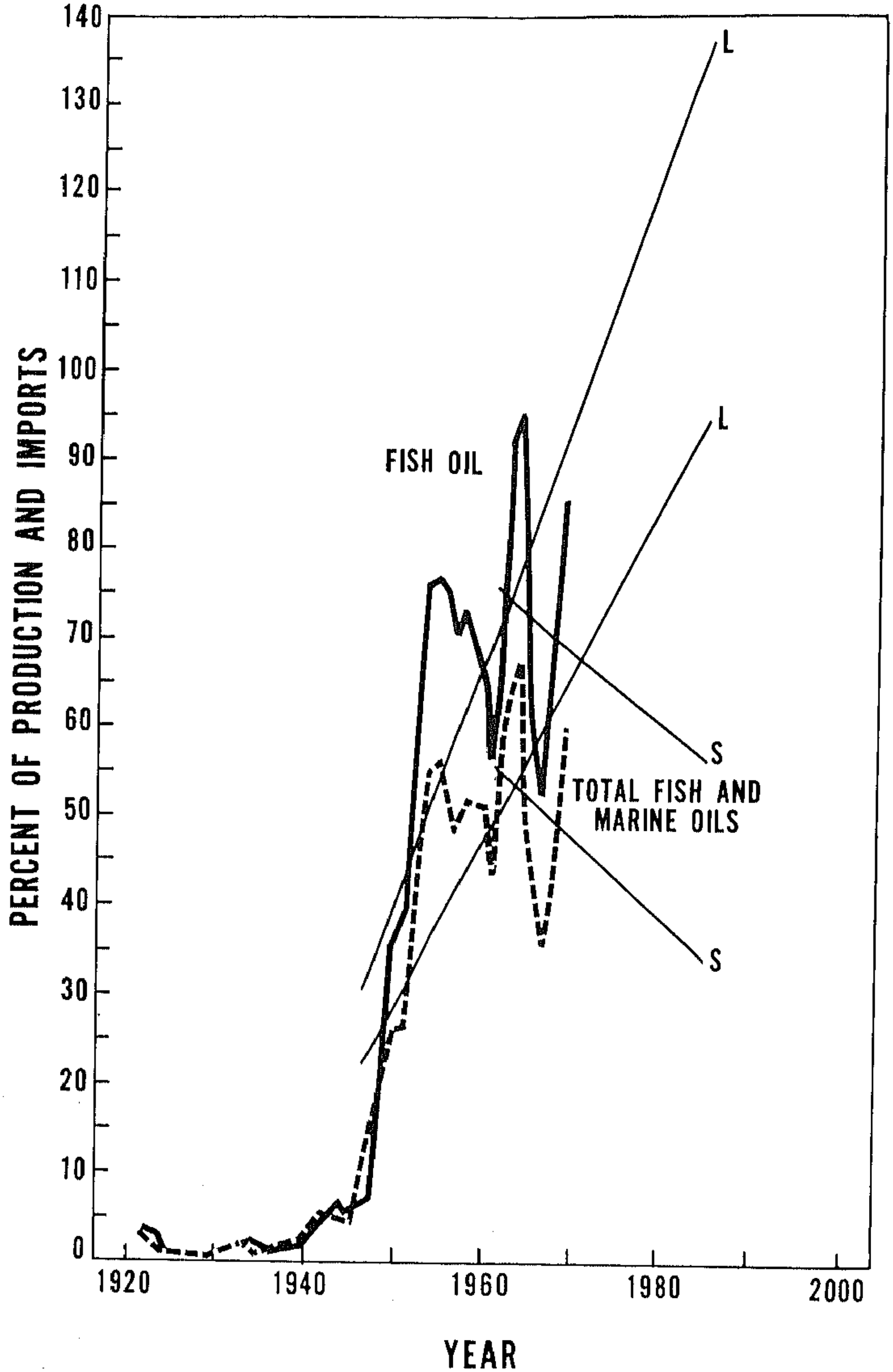

Figure 92.—Exports of fish and marine oils (3-year average).

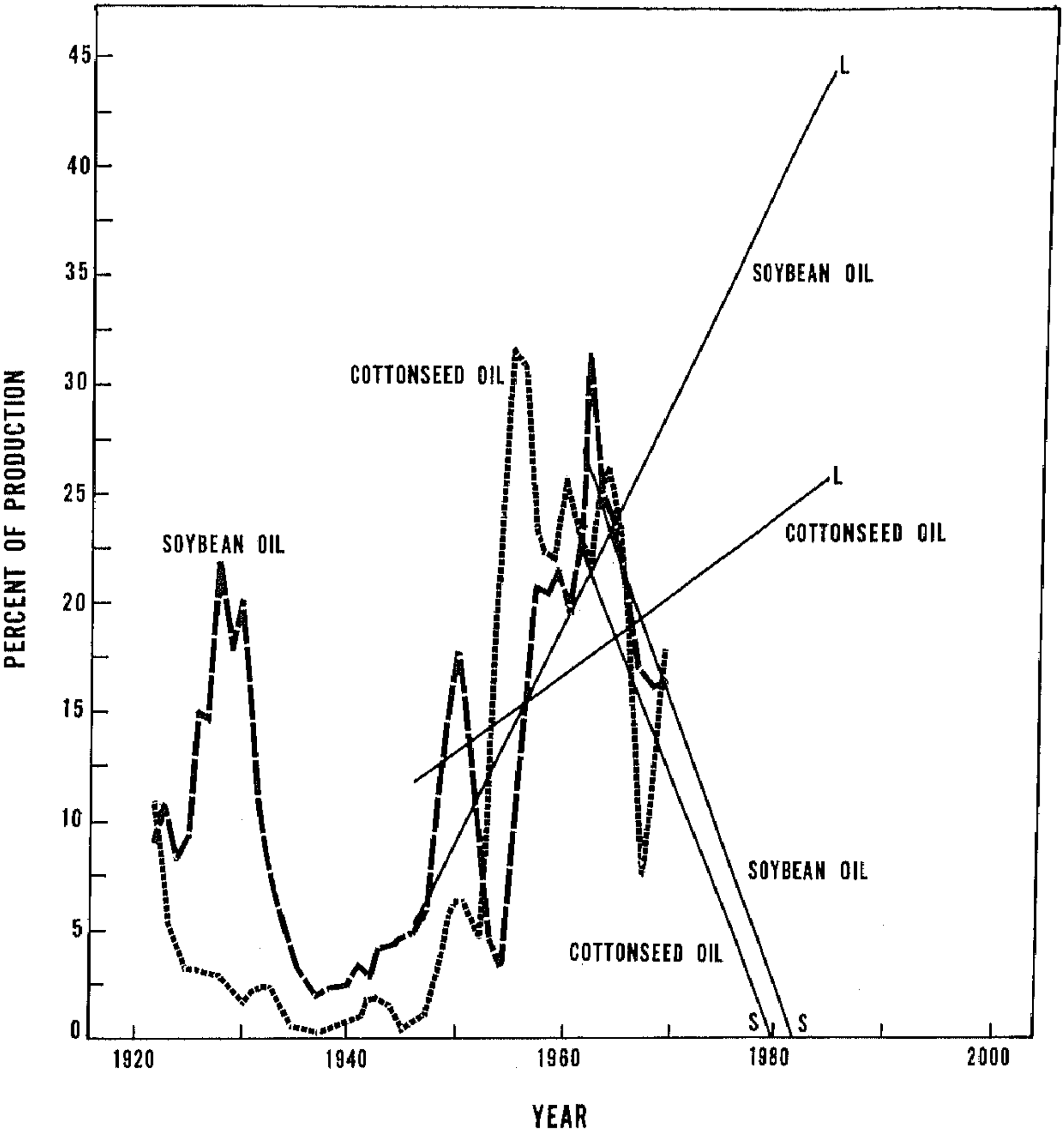

Figure 93.–Exports of soybean and cottonseed oils (3-year average).

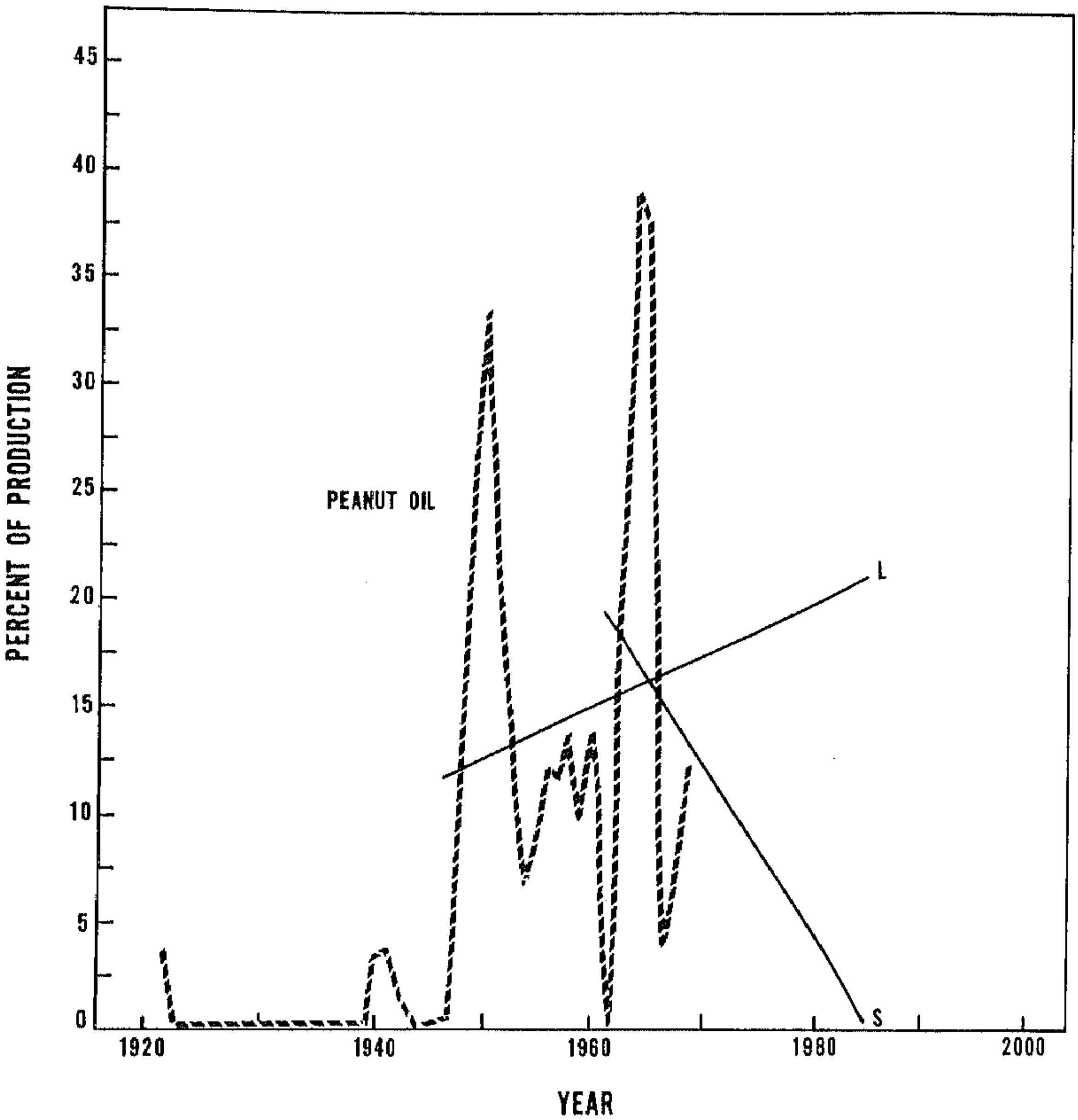

Figure 94.—Peanut oil exports (3-year average).

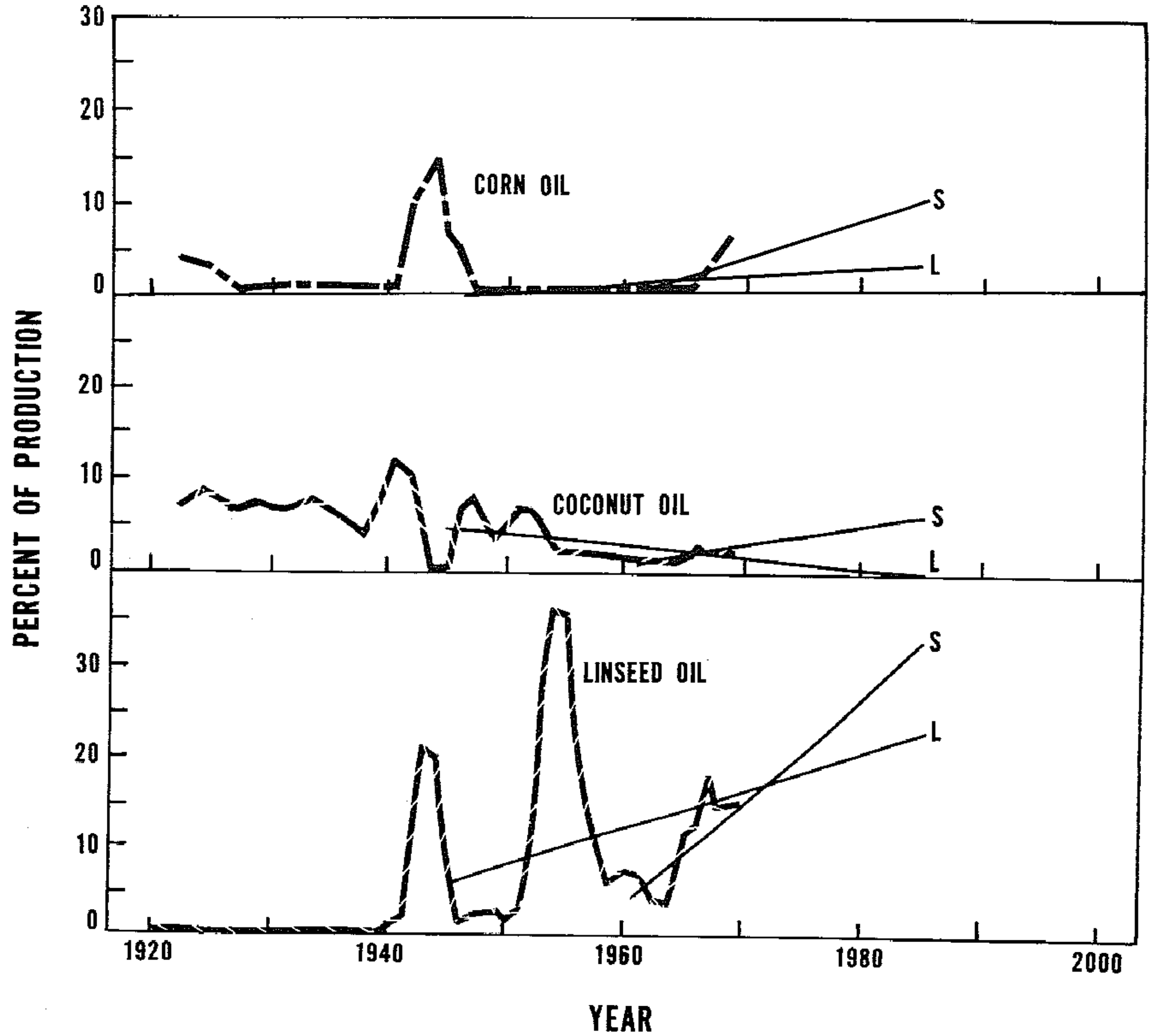

Figure 95.—Exports of corn, coconut, and linseed oils (3-year average).

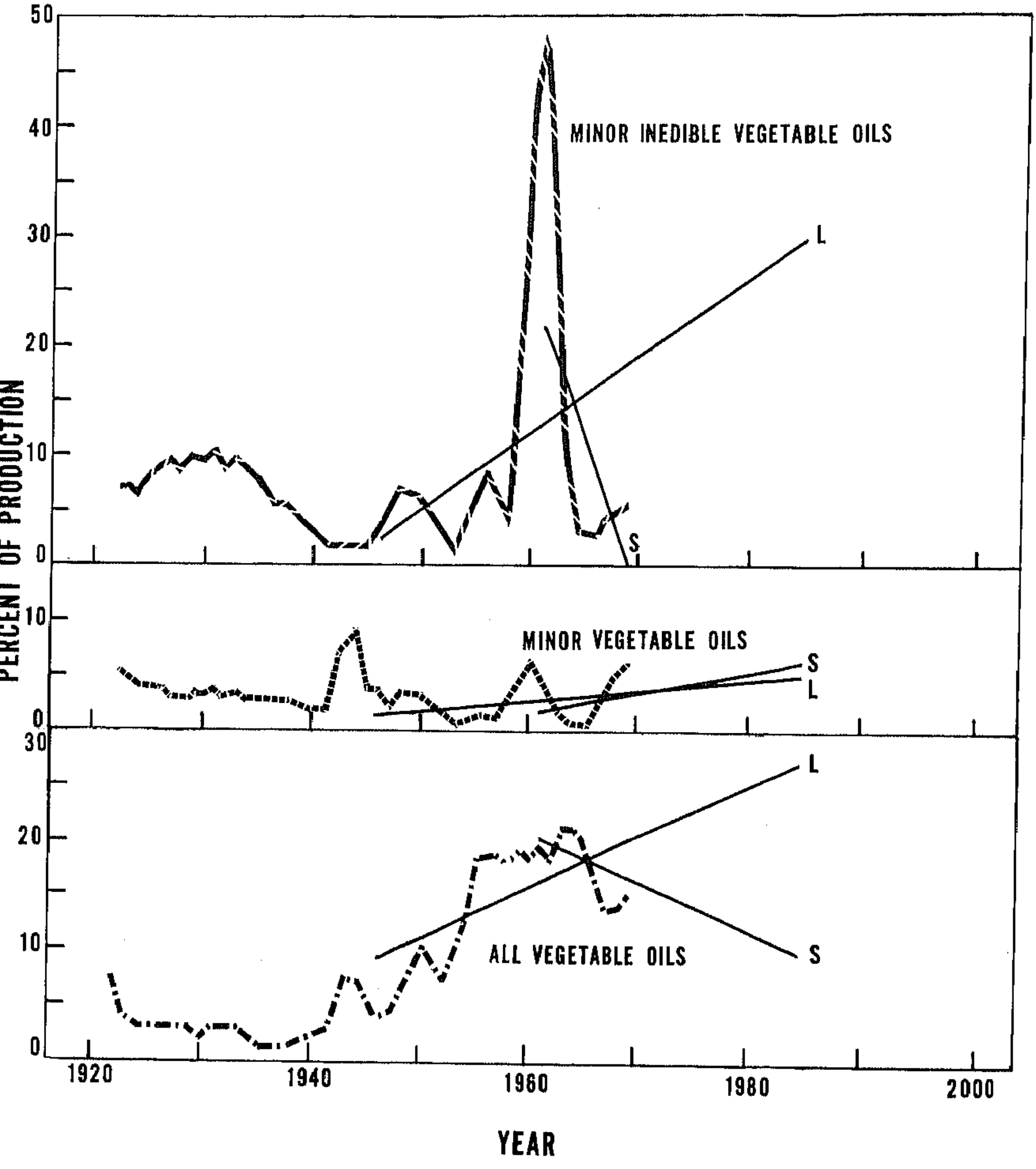

Figure 96.—Exports of all vegetable, minor inedible vegetable, and minor vegetable oils (3-year average).

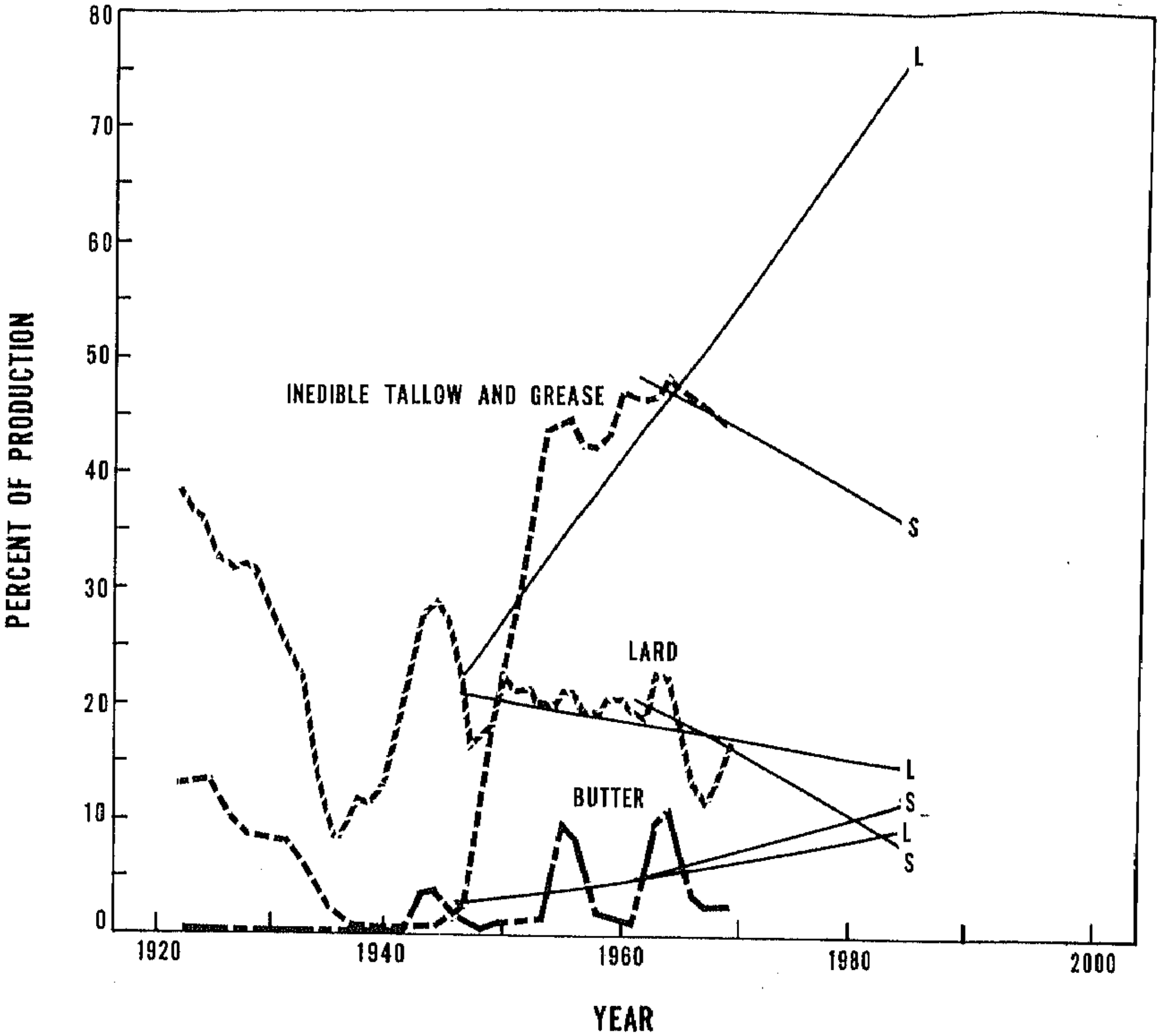

Figure 97.—Inedible tallow, grease, lard, and butter exports (3-year average).

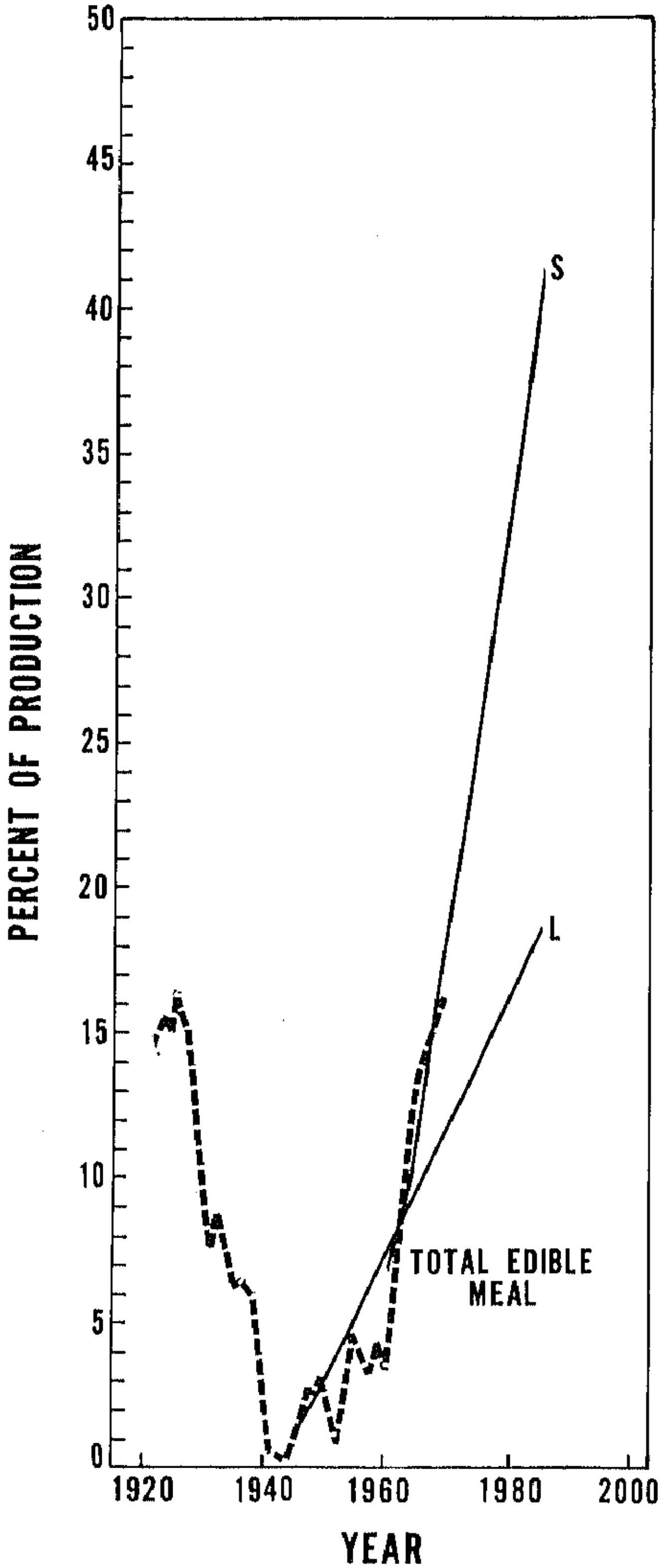

Figure 98.—Total edible meal exports (3-year average).

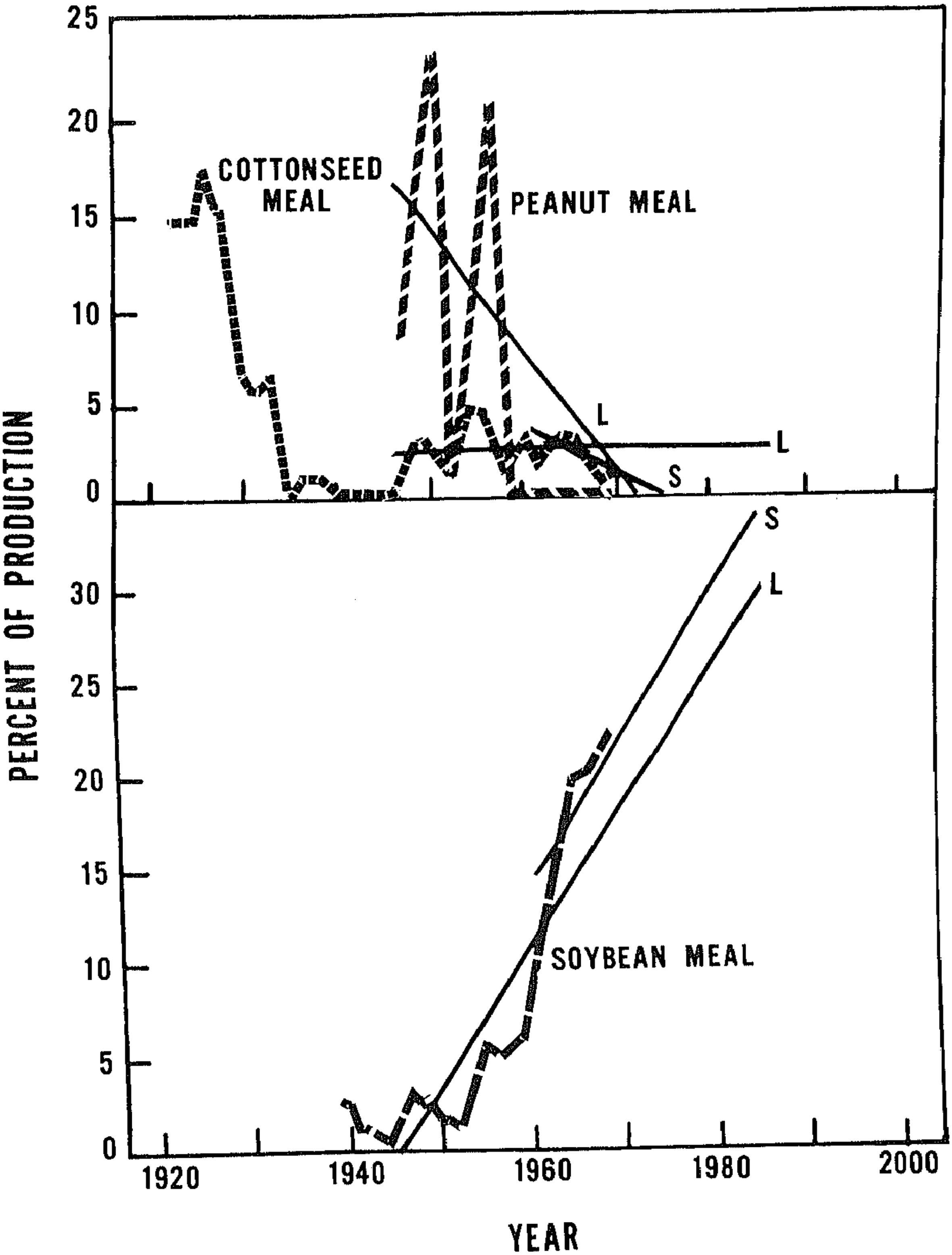

Figure 99.—Exports of soybean, cottonseed, and peanut meals (3-year average).

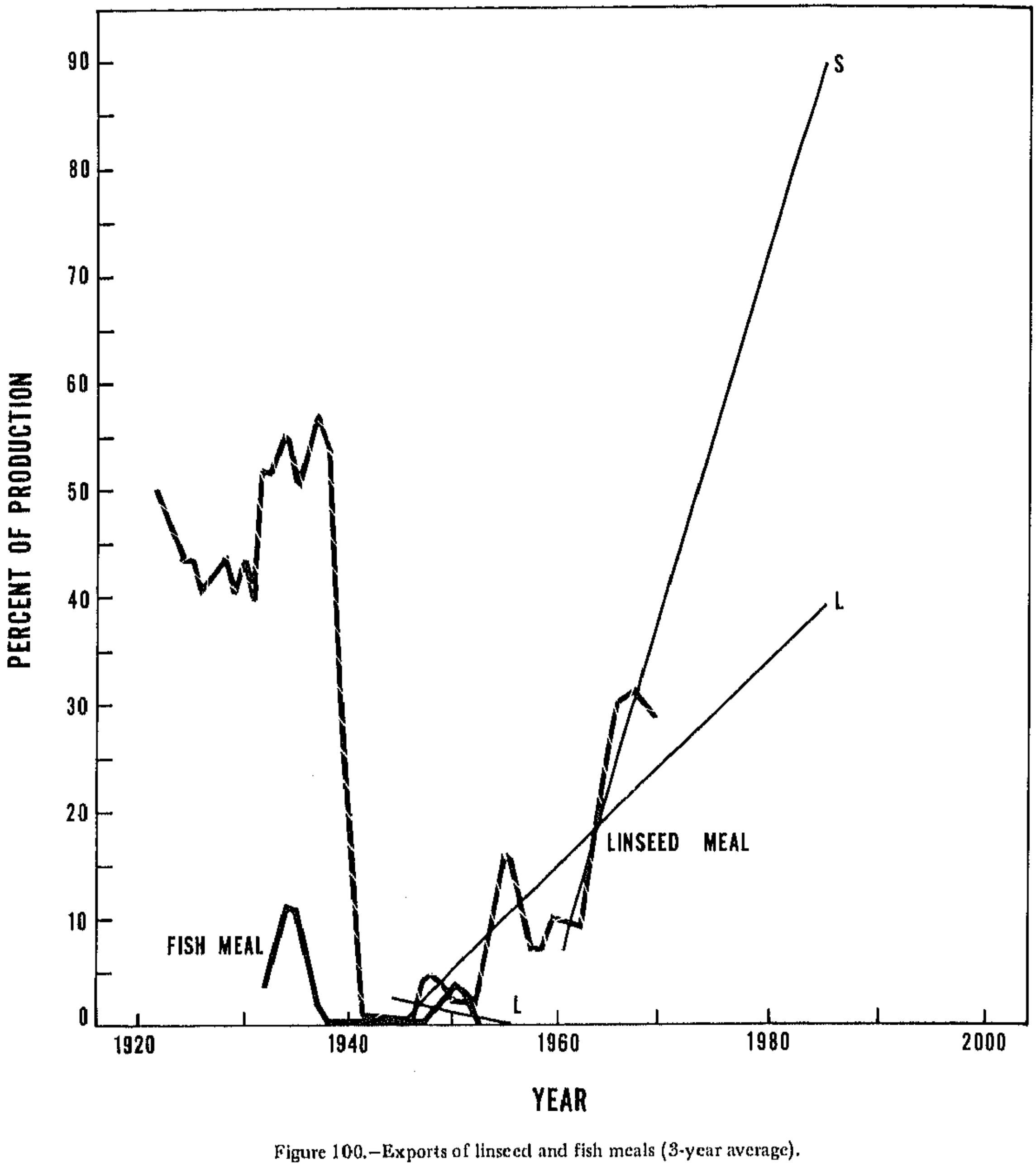

Figure 100.—Exports of linseed and fish meals (3-year average).

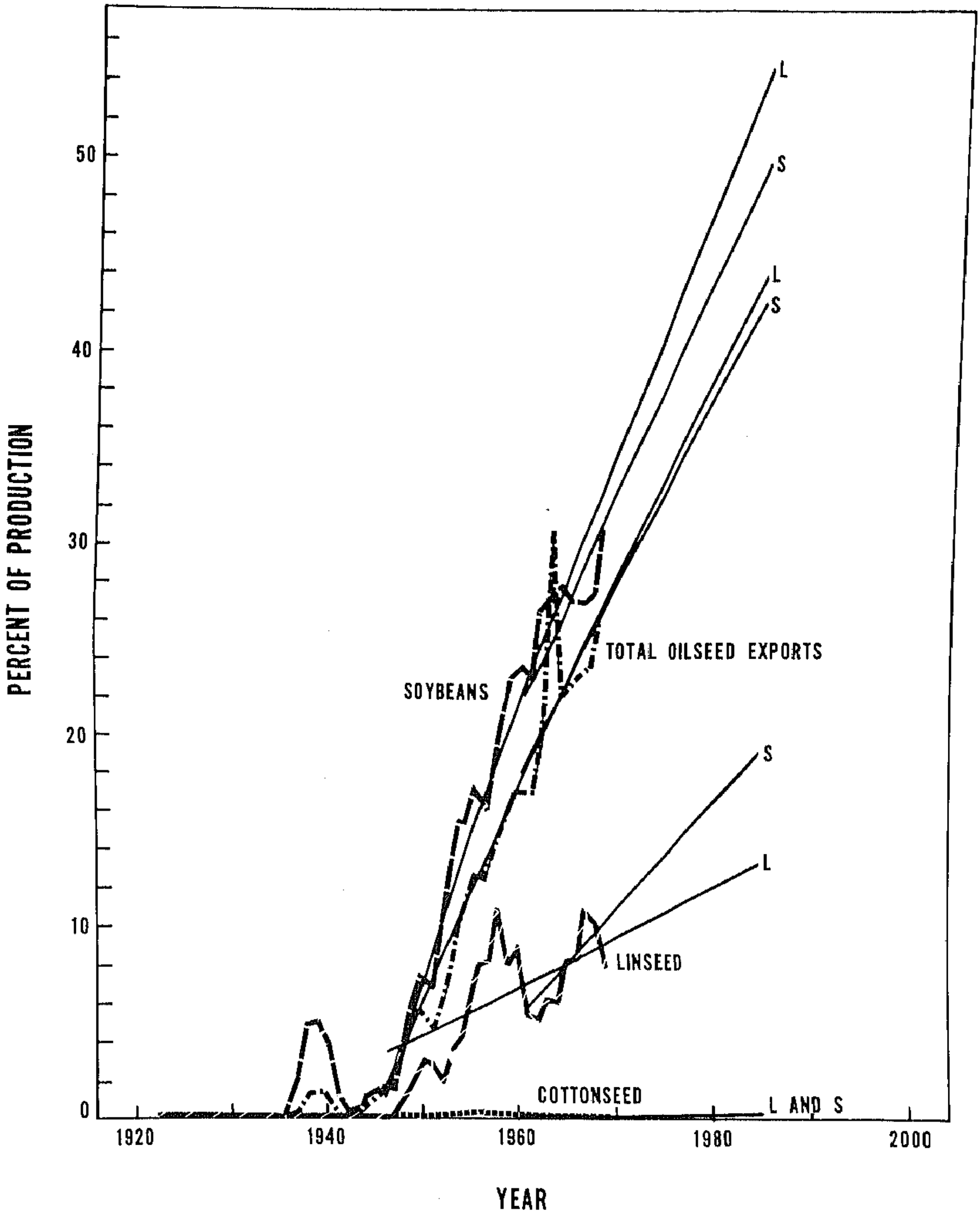

Figure 101.—Total oilseed, soybean, cottonseed, and linseed exports (3-year average).

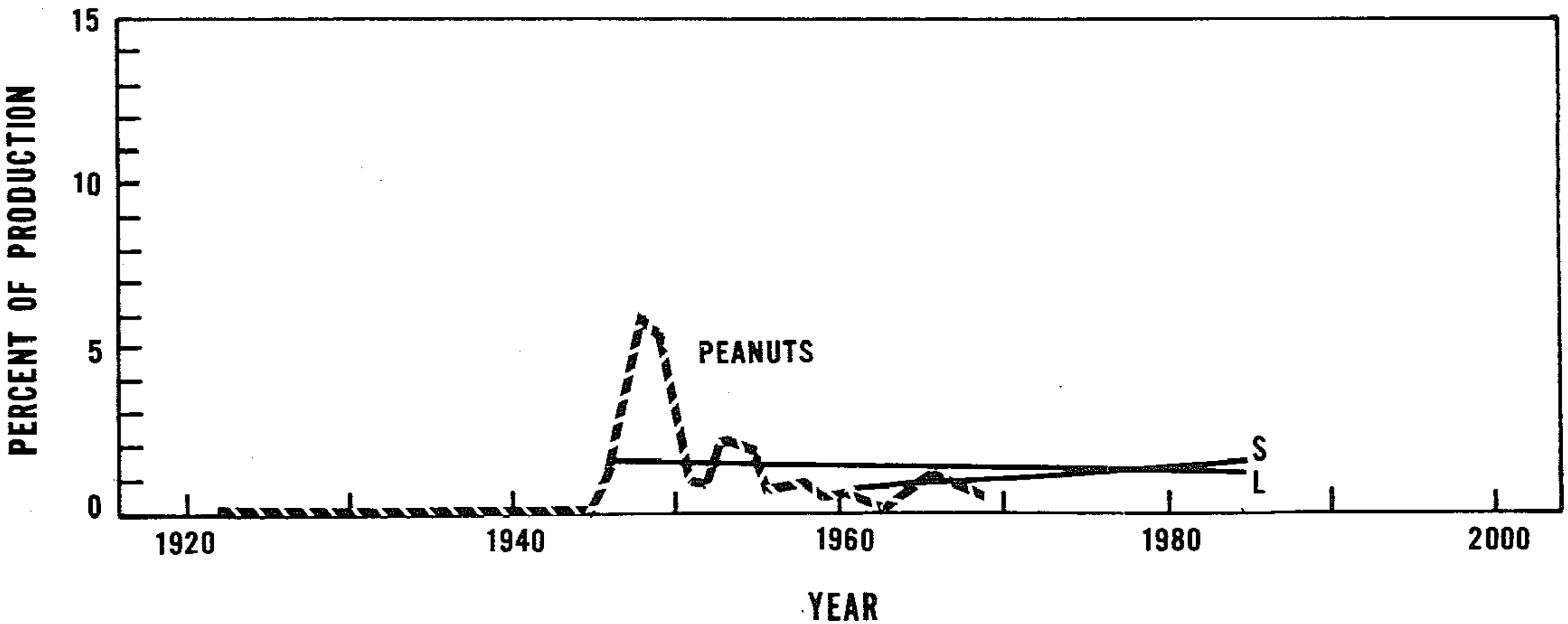

Figure 102.—Peanut exports (3-year average).

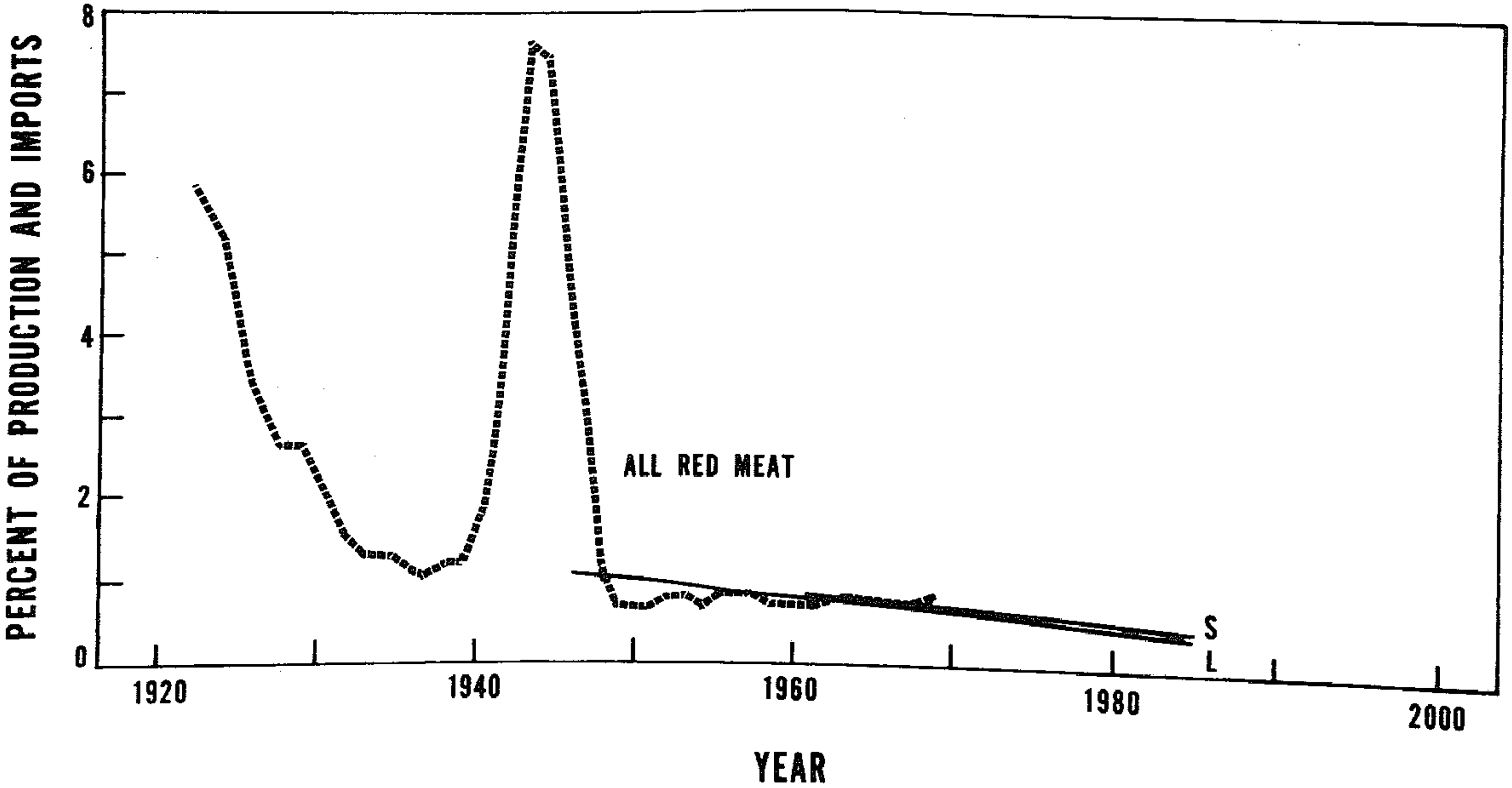

Figure 103.--All red-meat exports (3-year average).

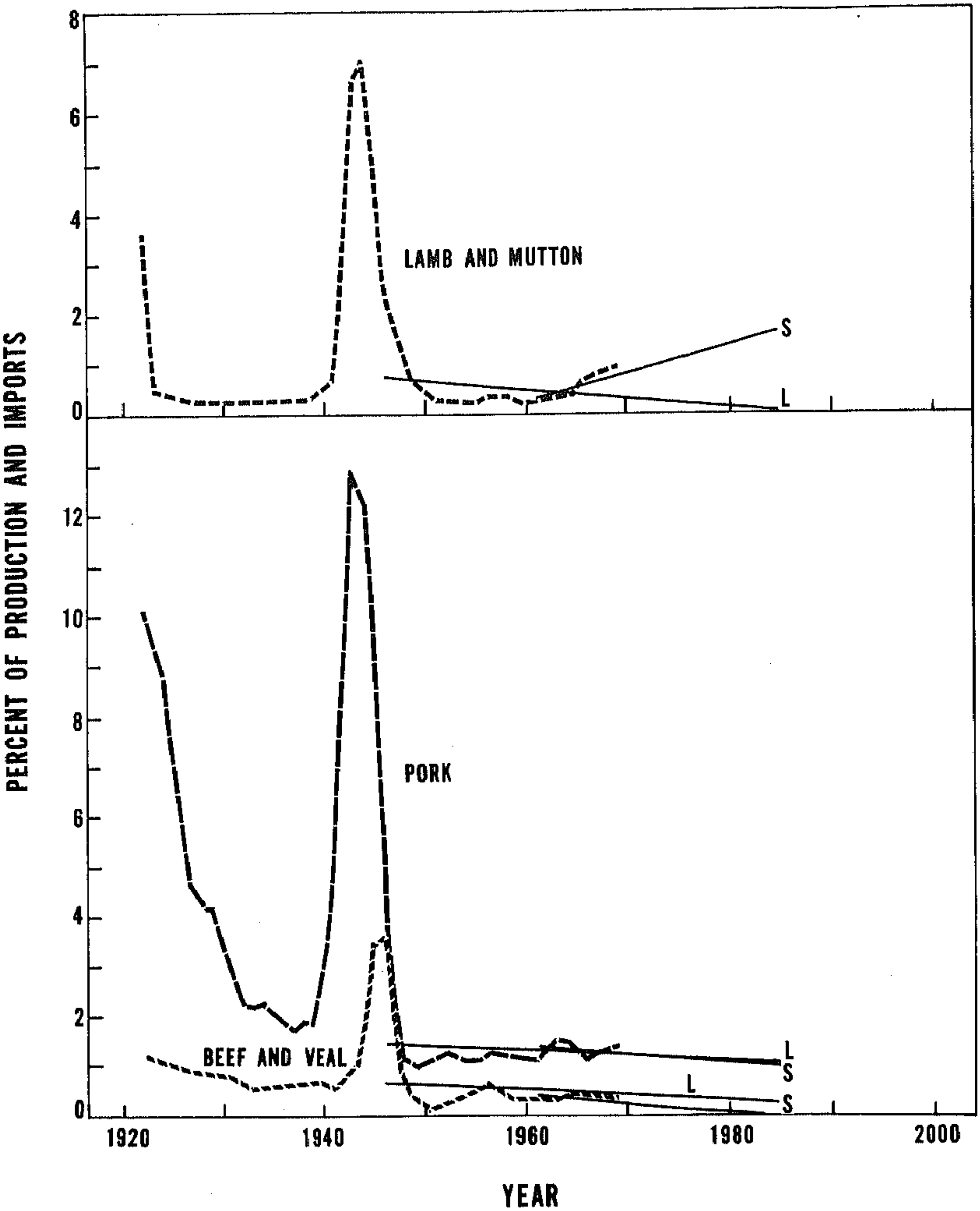

Figure 104.–Lamb, mutton, pork, beef, and veal exports (3-year average).

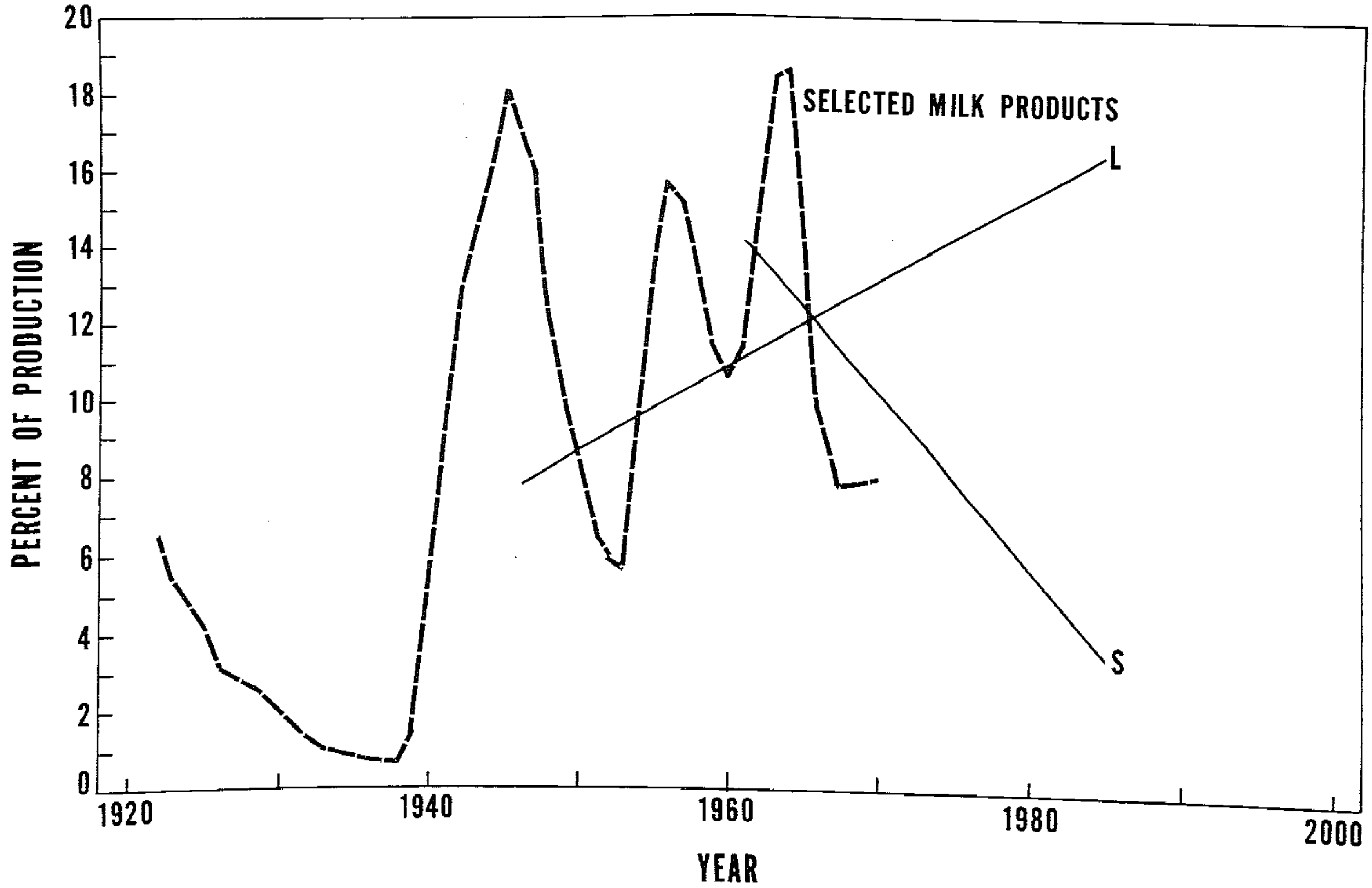

Figure 105.—Exports of selected milk products (3-year average).

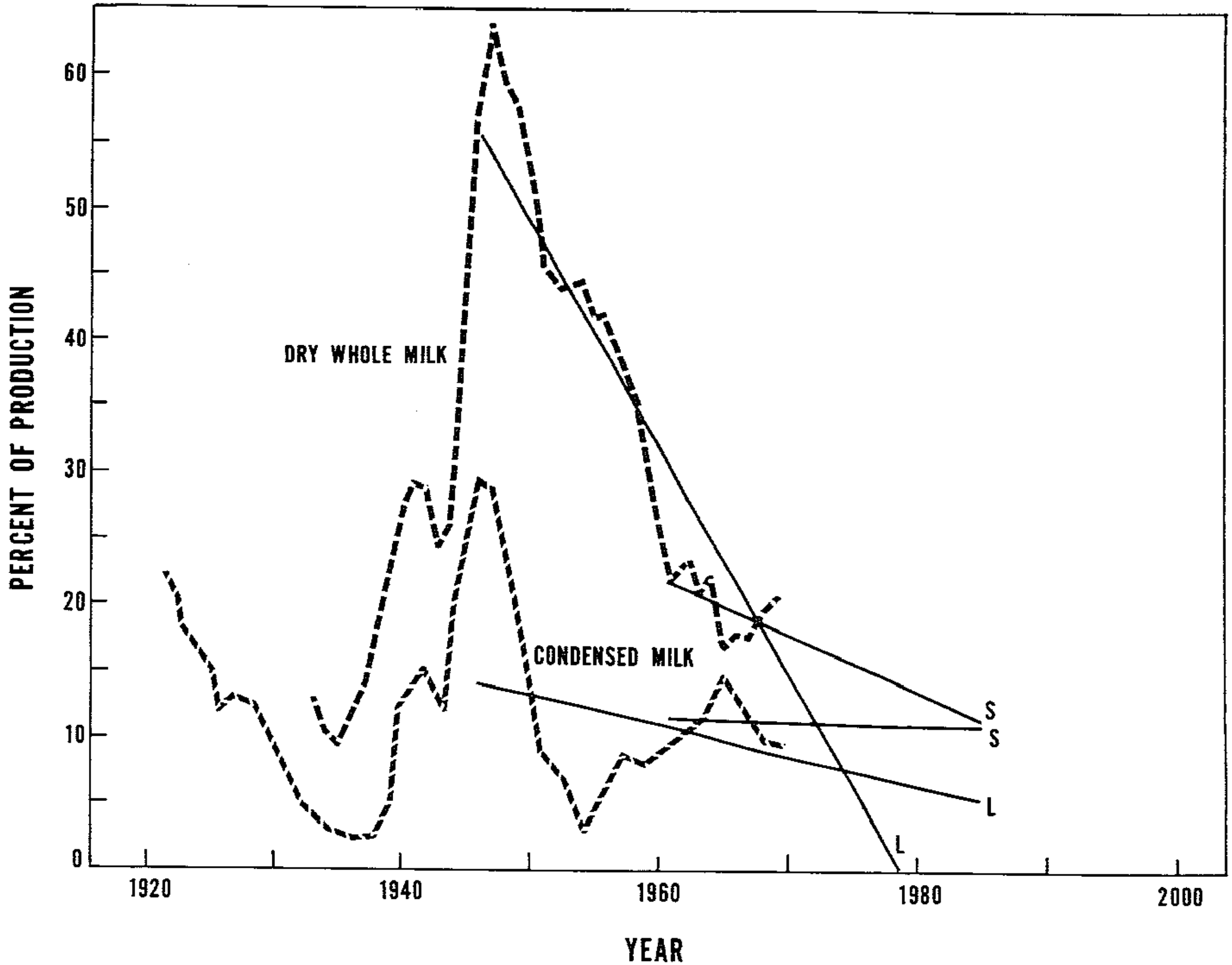

Figure 106.–Dry whole milk and condensed milk exports (3-year average).

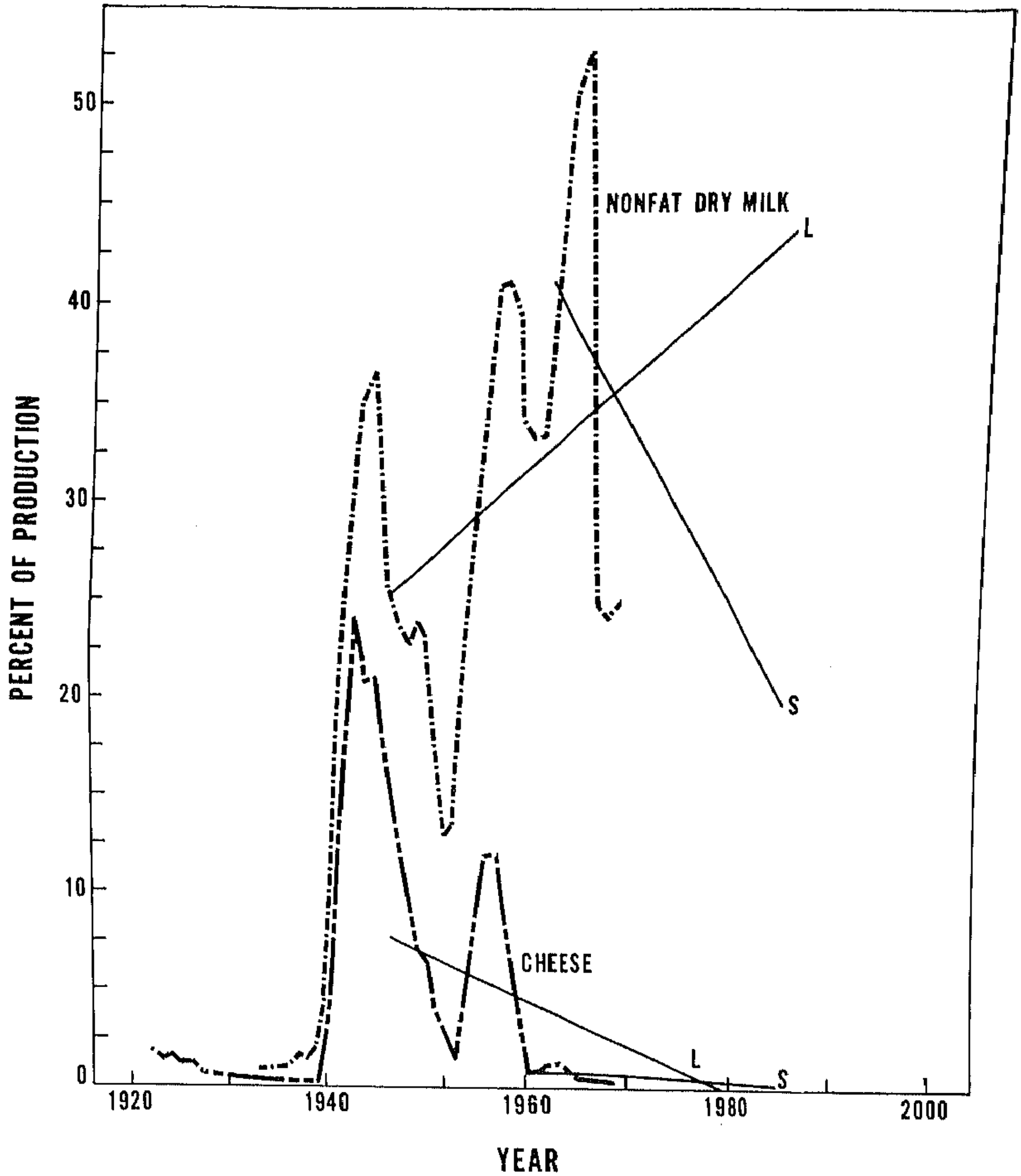

Figure 107.—Nonfat dry milk and cheese exports (3-year average).

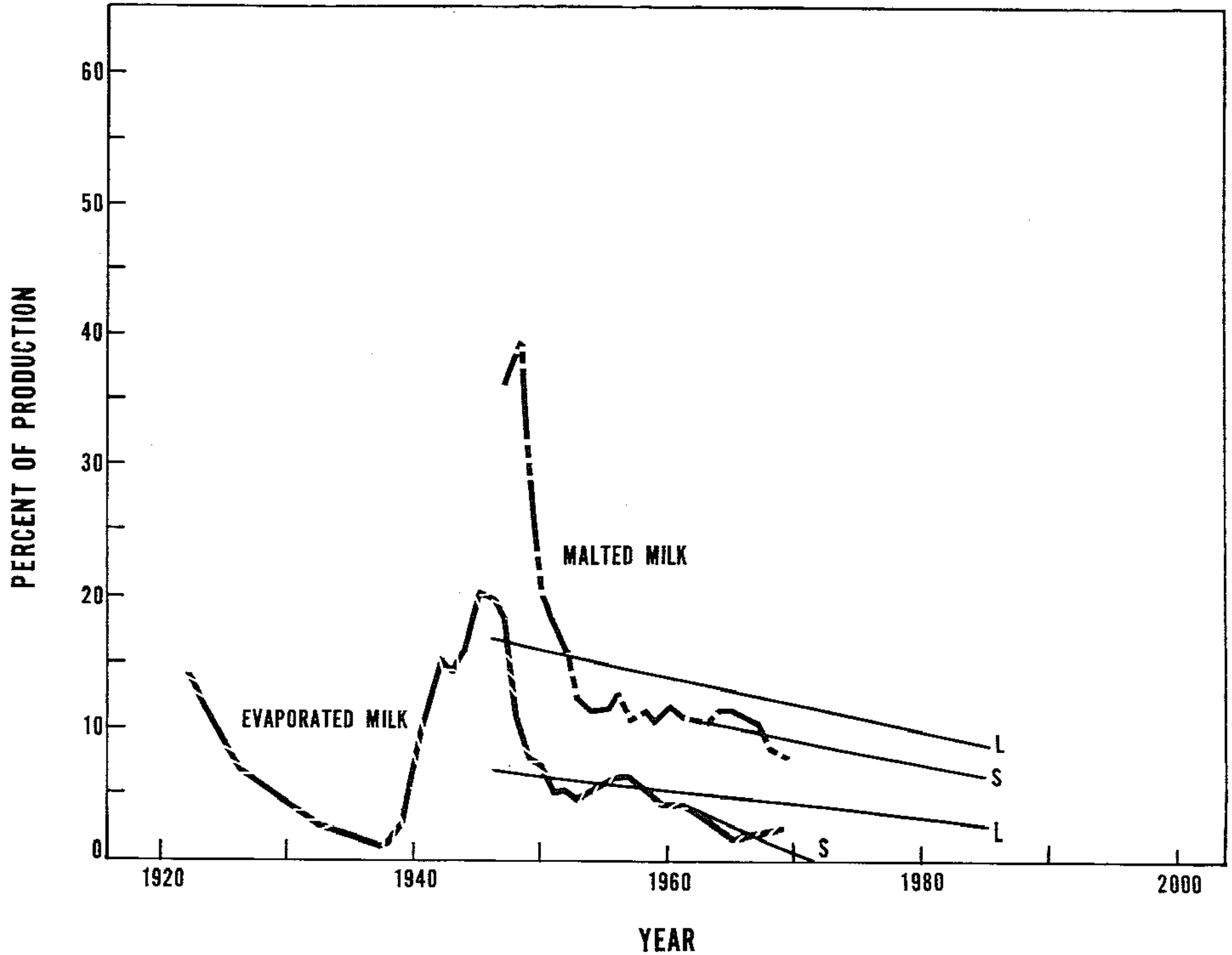

Figure 108.—Evaporated milk and malted milk exports (3-year average).

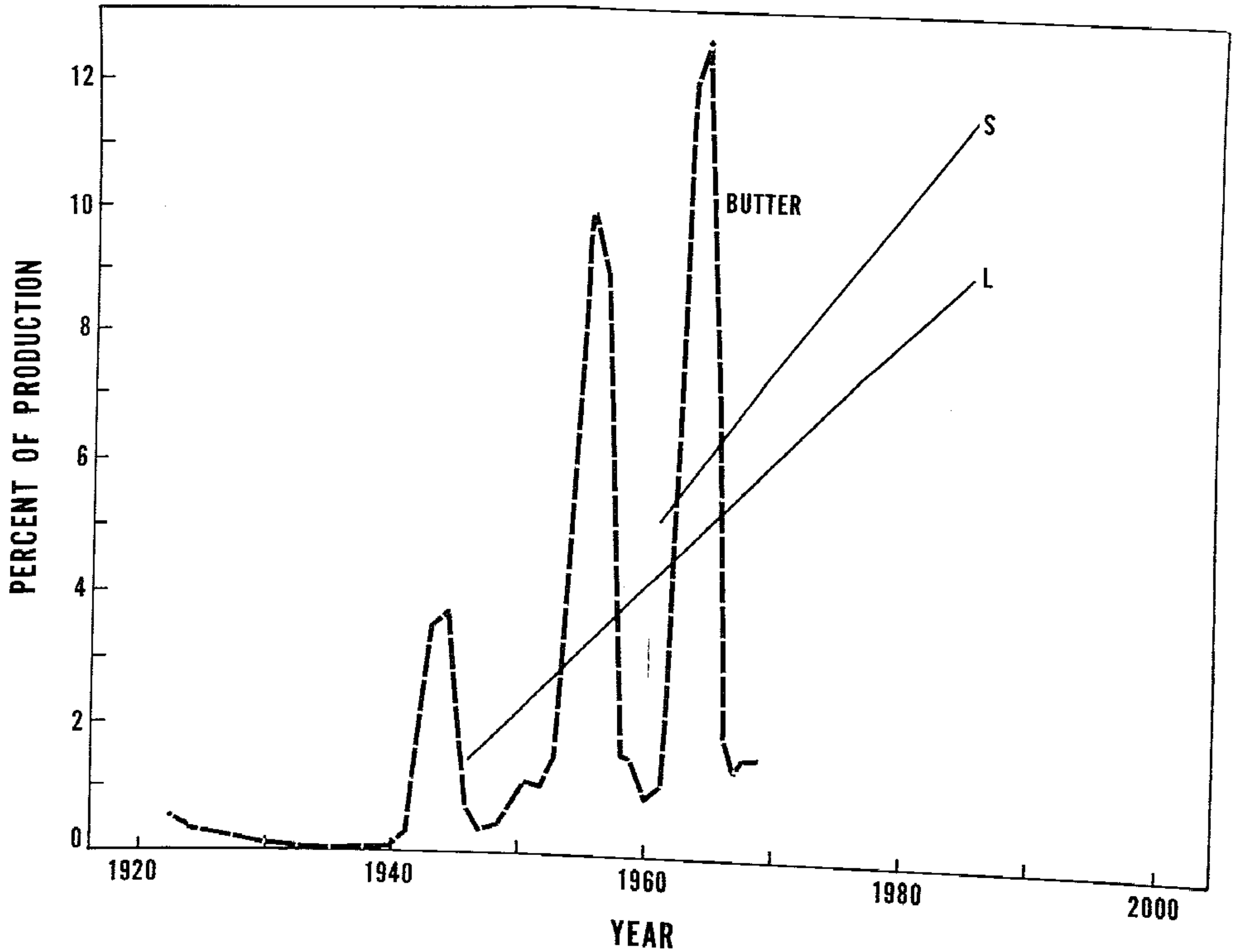

Figure 109.—Butter exports (3-year average).